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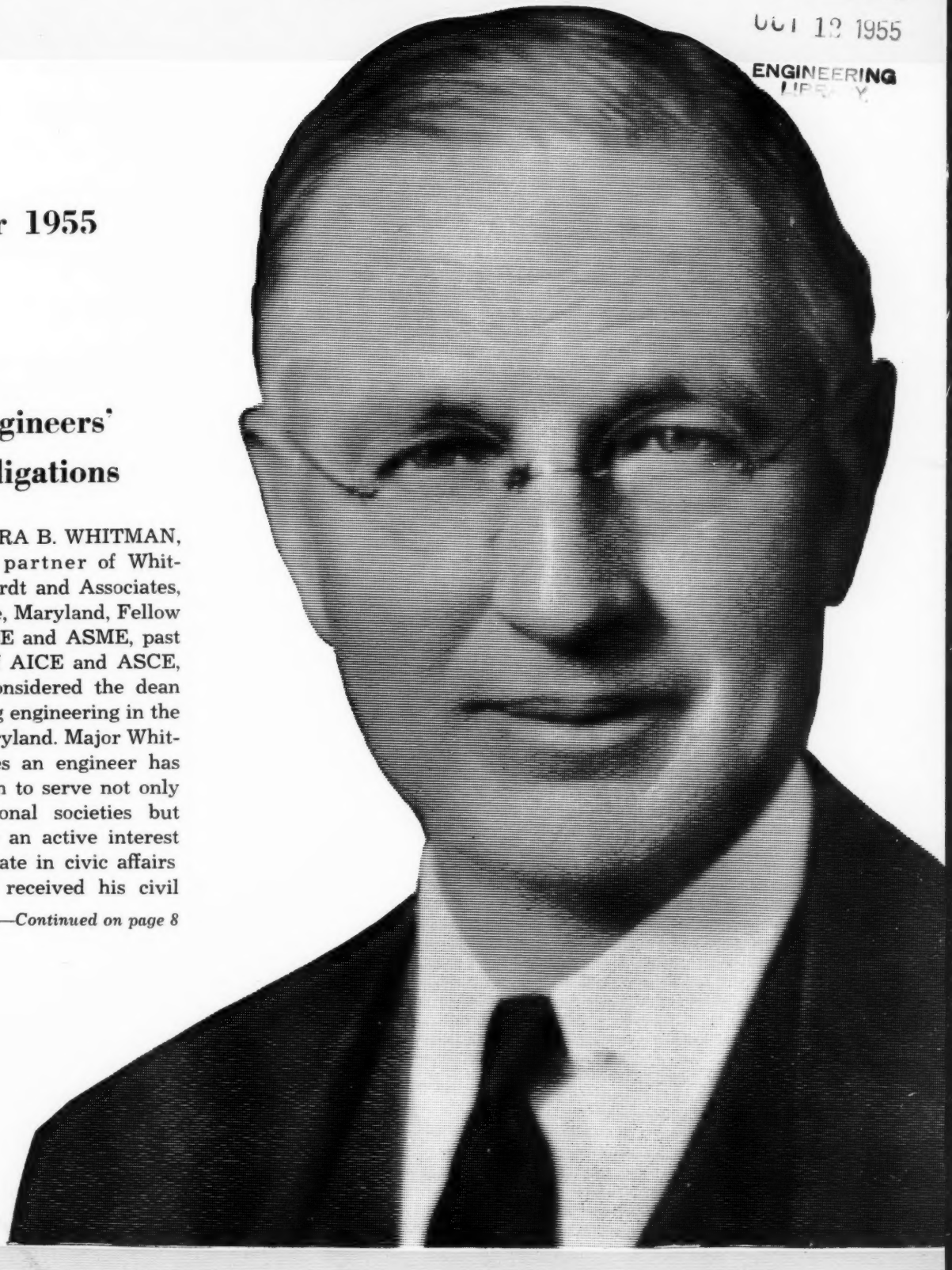


Engineers' Obligations

MAJOR EZRA B. WHITMAN, senior partner of Whitman, Requardt and Associates, of Baltimore, Maryland, Fellow of both AIEE and ASME, past President of AICE and ASCE, might be considered the dean of consulting engineering in the State of Maryland. Major Whitman believes an engineer has an obligation to serve not only his professional societies but also to take an active interest and participate in civic affairs

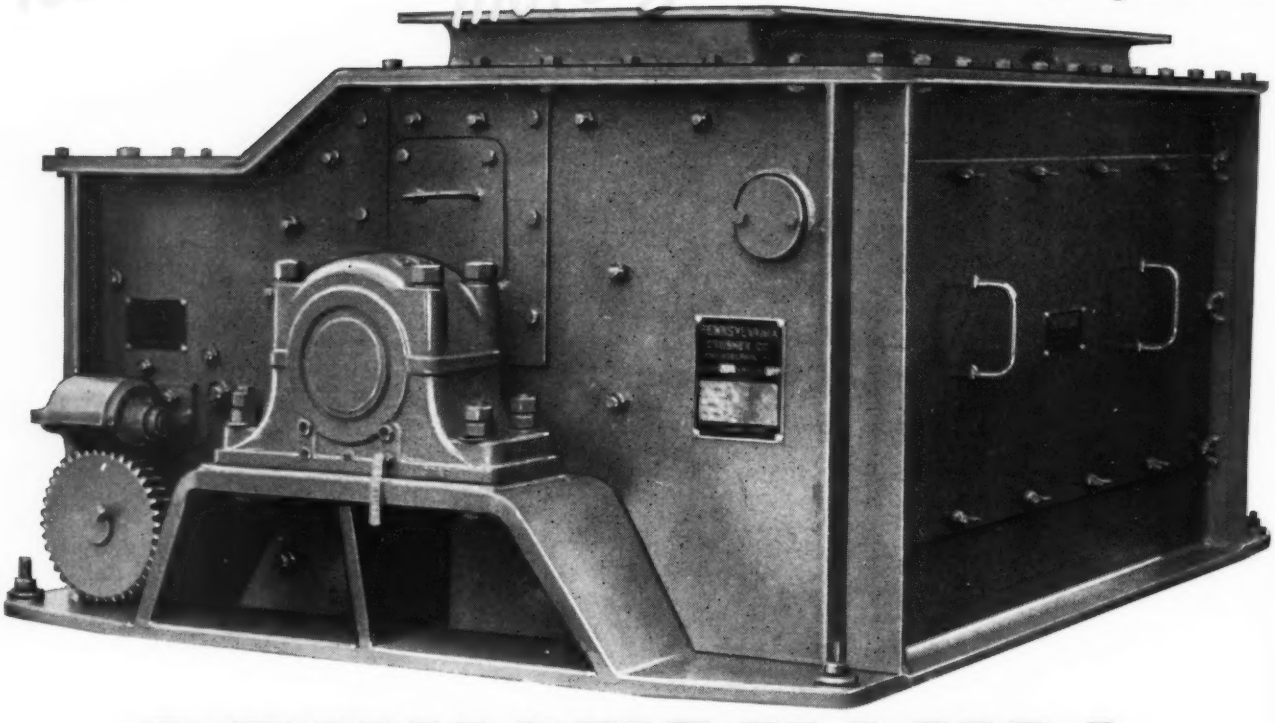
When he received his civil

—Continued on page 8

The Consulting Engineer's Professional Magazine

less overgrinding more granulation

when you use



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(patented ring hammermills)

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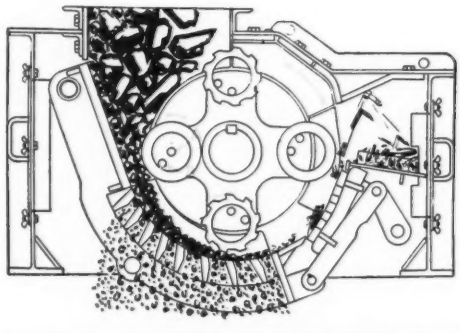
Bath Iron Works Corporation
West Chester, Pennsylvania



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(See page 98)

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October 1955

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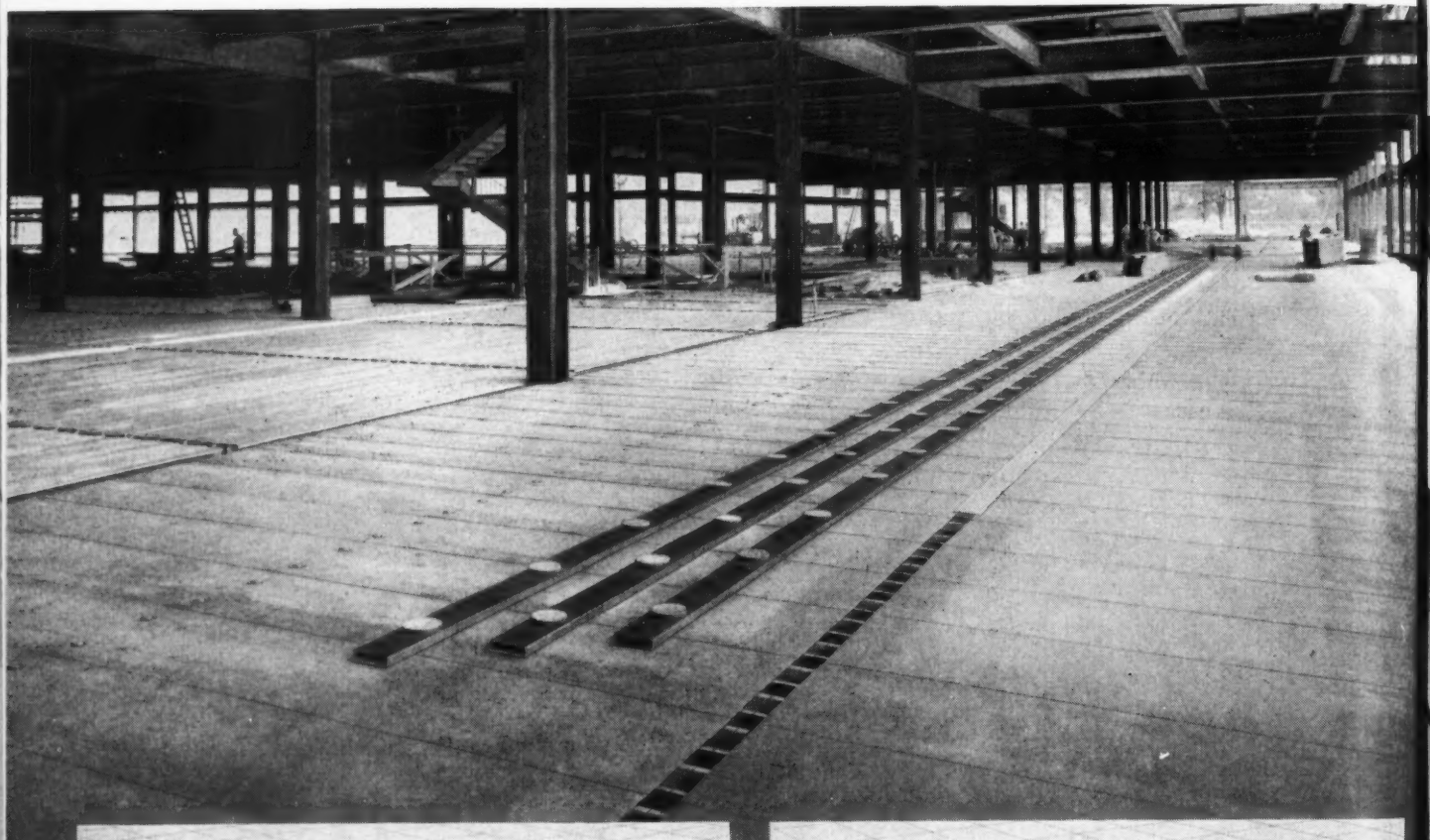
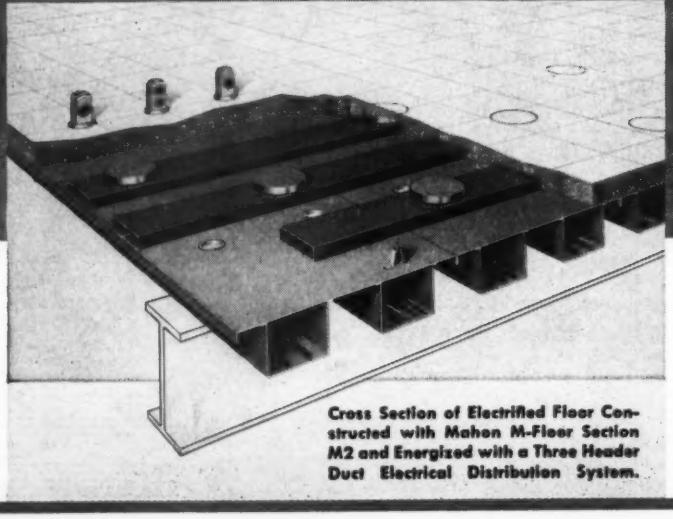
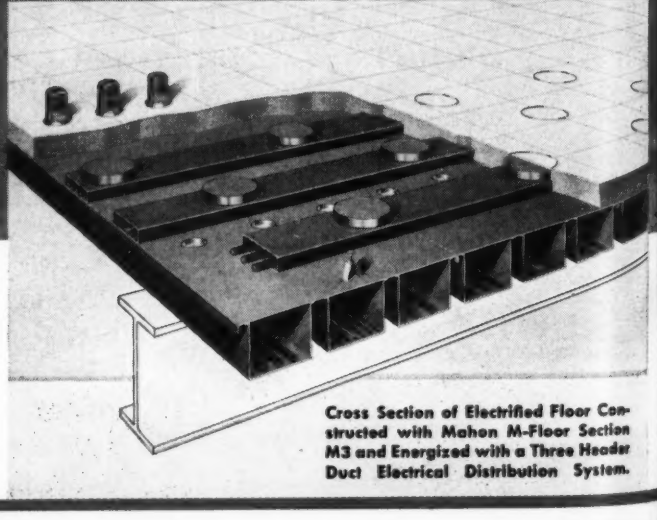




Cross Section of Electrified Floor Constructed with Mahon M-Floor Section M2 and Energized with a Three Header Duct Electrical Distribution System.



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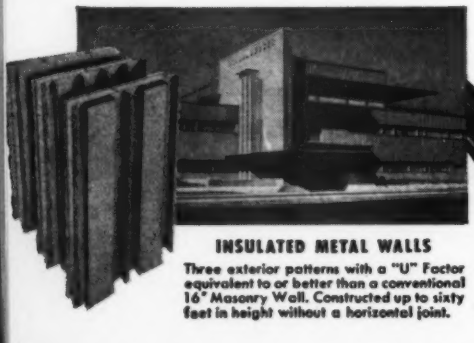

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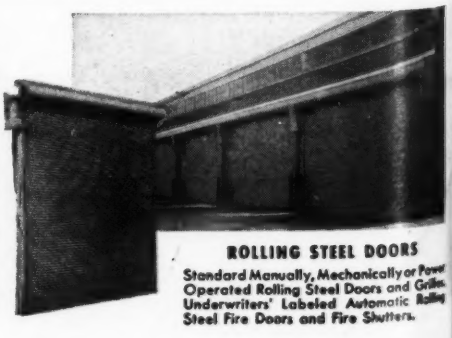

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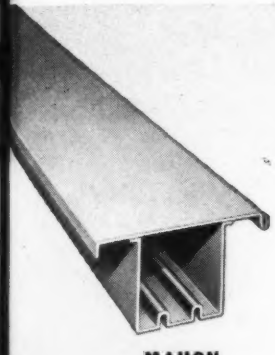
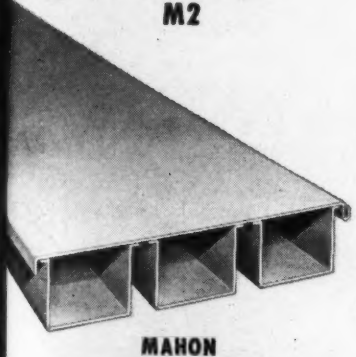


MAHON M-FLOOR SECTION M1

MAHON M-FLOOR SECTION M2



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MAHON

Major Ezra B. Whitman

—Starts on front cover

engineering degree from Cornell University in 1901, his home town of Baltimore had no sewerage system. In fact, Whitman planned his college courses with the idea that he might be instrumental in planning a system for the city. As Division Engineer of the Sewerage Commission of the city of Baltimore, beginning in 1906, he designed a sanitary laboratory and pilot treatment plant, and based on this experience, he then designed the Back River Sewage Disposal Works, incorporating advanced types of settling basins and trickling filters, and chlorination before entering the final settling basins.

Electric power was not available at the Back River site but there was a fall of 18 feet from the final settling basins to the river. Whitman, recognizing the possibilities, took a correspondence course in electrical engineering and designed a hydroelectric plant to furnish power for the disposal works.

After graduation he first worked on a railroad survey, starting work in the field at seven in the morning and working, as an instrument man, until it was too dark to see the cross hairs. Then, after supper, he plotted the field notes of the day's work until nearly midnight.

A little over a year later, Whitman and a classmate (each 22 years of age) opened offices in New York as Consulting Engineers, but after failing to purify the packing house wastes of Armour and Company and Swift and Company at Fort Worth, Texas, he returned to New York and worked in the chemical and bacteriological laboratories at the Cornell Medical College. He then established a laboratory in connection with his own work for the analysis of water and sewage. The fact that he could run such a laboratory was responsible for his appointment on the Baltimore Sewerage Commission.

"In 1911, when I was appointed Water Engineer and President of the Water Board of Baltimore, four of the best known water supply engineers in the country had recommended slow sand filtration for Baltimore, and my predecessor had designed such a plant. My studies, including the operation of an experimental slow sand filter, convinced me that a rapid or mechanical filter should be built. This was done, though no engineer up until that time would do otherwise than build slow sand filters.

"In the first World War, I was in the Construction Division of the Army as officer in charge of utilities and Construction Quartermaster assigned to finish the construction of Camp Meade, Maryland. My detachment initially consisted of four officers and 125 men — an inadequate force to properly maintain the camp. Fortunately, after considerable difficulty, my work was taken out from under the Constructing Quartermaster and put in the Construction Division, which operated directly under the Secretary of War. The men in this division were thoroughly familiar with the work that should be done, and ultimately I had 16 officers, 600 men, and a labor battalion of 1100 men under my direction.

"Here at Whitman, Requardt and Associates we have nearly 200 engineers. We find that the best way to develop these younger engineers is to give them a job to do and place the full responsibility for its completion upon them, giving them such guidance as they may need to carry out the project. As these men meet these responsibilities in an efficient manner they are given greater and greater responsibilities. We have found quite frequently that a man may prove a failure in certain branches of work but in a different capacity may prove to be an excellent worker. In other words, we find that square pegs in round holes do not work. As many engineering offices throughout the country have found, it is increasingly difficult to get qualified engineers to carry on our work. Many of the engineers in our organization have gotten their training with us.

"I recently served on an Advisory Committee to the United States Civil Service Commission appointed to work with the engineers of the Civil Service Commission on the matter of selecting engineers and regarding the requirements for engineering positions (see page 76). One of our recommendations was separation of professional engineers from mere technicians. Our Committee also believed that the bars for entering engineers should not be lowered in order to attract more applicants. We felt that if anything the requirements should be raised.

"In our own organization we encourage our engineers to take an interest in civic affairs. I do not mean to enter into politics, but there are many areas where the professional knowledge of an engineer would be of great service to his community. An engineer has specialized knowledge and he can make good use of it by applying it to the betterment of the community in which he lives. For instance, an engineer with some knowledge of the electrical industry, the gas industry, the street railway industry, and the railroad industry should be a logical selection for a post on a public service commission. A civil engineer may well serve on a state roads commission, while an engineer with experience in water supply work could well serve on any board connected with developing water resources for his city."

Major Whitman speaks from experience since he has served as Chief Engineer and President of the Water Board of Baltimore, Chairman of the Maryland Public Service Commission—the first engineer appointee—and Chairman of the Efficiency and Economy Commission of Baltimore. On this commission, twelve top industrialists worked with him, bringing about a reorganization of the municipal government and a substantial reduction in the city tax rate. He was also Chairman of the Maryland State Roads Commission for over six years. ▲▲

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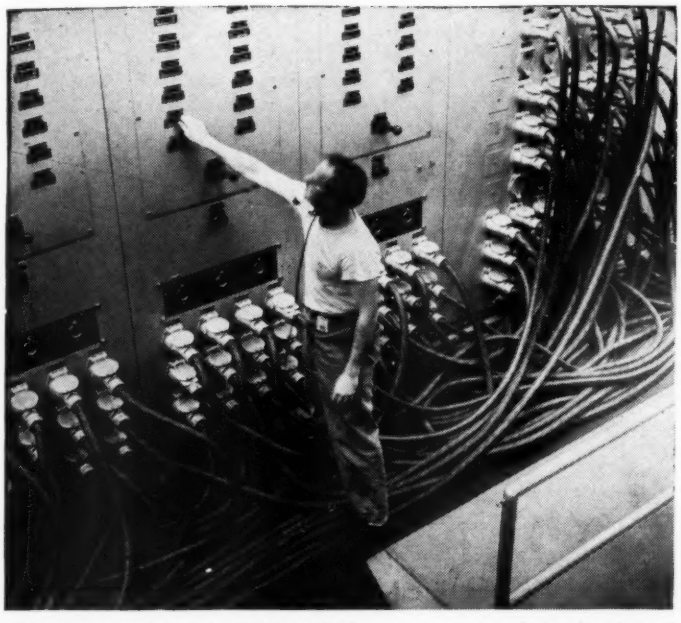

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DETACHABLE COMPONENTS On any equipment that must be disconnected for inspection, repair or replacement, plugs and receptacles quickly pay for themselves by saving man hours and shortening shut-down periods. Complicated multiple conductor connections are instantly and accurately broken and remade as polarization is not disturbed.

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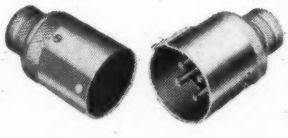

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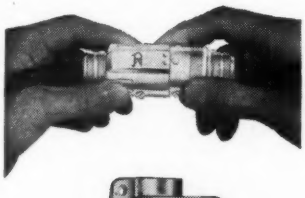

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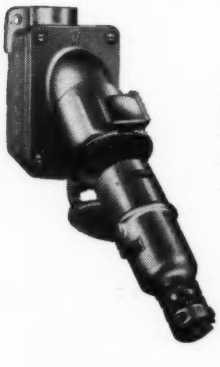

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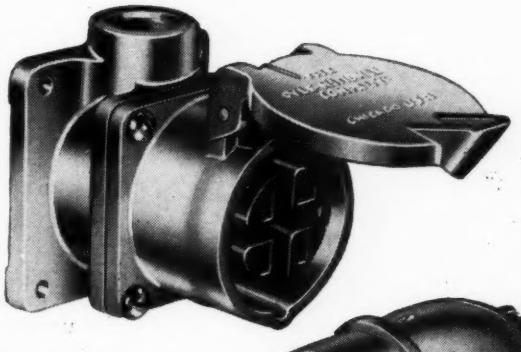

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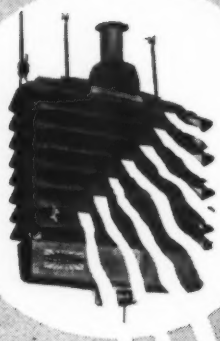

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silent and draft-free
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- Comfortably heats workers and machines within radiation area.
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READERS' COMMENT

For Discussion

Sir:

The New York Association of Consulting Engineers has been much interested in the coming meeting in St. Louis of local engineering organizations concerned with a strong affiliated association; and our representative will no doubt be present. As you know the NYACE has prepared a booklet covering its Constitution, Code of Ethics, Schedule of Fees and Standard Form of Agreement Between Architect and Engineer. It now has in preparation General Conditions for Mechanical and Electrical Work which will undoubtedly be of interest to engineers nationally. It also is attempting to interest manufacturers in issuing catalogue index cards with their literature to assure a better use of the material filed.

The latter part of August, I called on Mr. Coe, Technical Secretary of the National AIA. He has brought the matter of these Index Cards to the attention of the Producers' Council but so far the Council has not favorably considered the idea. During a discussion of the activities of the AIA with Mr. Coe, it developed that there is a suggestion being considered by the Association for the admittance to membership in the AIA of engineers whose work is closely affiliated with that of architects. A discussion of this idea at the St. Louis meeting may be premature but you will no doubt find news in the idea.

Harry Terry
Consulting Engineer
New York, N.Y.

Permanent Magnets

Sir:

Reference is made to the article on "Permanent Magnets," "Science Fiction?" on page 60, of the September issue of CONSULTING ENGINEER. . . . Quoting, "We would have here a device from which more kinectic energy would be derived than was being used to drive it. This is, of course, not perpetual motion, in the classic sense, any more than is the use of any other natural force such as heat from the sun. . . . This idea is new. It is too early to say whether it will work."

Well, the idea is not new; it is very old and any competent engineer or physicist can testify that it will not work as claimed. It is, in fact, an outright claim for perpetual motion and the analogy of using a natural force, such as heat from the sun, is not valid. It is safe to say that the National Research Council is not wasting any time on that idea. No responsible engineer will trouble to investigate the details of any machine claimed to give perpetual motion. It is sufficient to show that such a claim is made. Nor will he argue with the inventor or his victim because they understand technical terms only in their colloquial sense and misuse or misunderstand scientific terms having precise meanings.

This is particularly true with the words "force" and "energy." The confusing of these two words is responsible for most of the fallacies in the impossible quest for perpetual motion. In the above quotation the heat (energy) of the sun is identified as a natural force whereas heat is in no sense the same thing as a force. Foot-pounds and pounds are two different things; as different as acres are from feet or sodium-chloride is from sodium. Before one can safely discuss energy he must know exactly what is meant by energy and stick to the precise meaning of the term.

While a machine, per se, can multiply force it cannot multiply or alter the total amount of energy—which remains constant—within the system containing the machine. The system cannot give out energy except at the expense of energy stored within the system. . .

Probably all alleged perpetual

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fills your packaged chiller needs for economical installation, dependable performance

Here it is — Acme's new "C" Series Flow-Therm compact package complete with compressor — designed specifically for modern refrigerants. Constructed with proven Acme components, including a great new Dry-Ex®, it's a packaged liquid chiller that fits all the requirements of architects, consulting engineers and contractors for size, efficiency and ease of installation.

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FLOW-THERM proven as Heat Pump

Heat pump applications have been successful in a wide range of climates. Factory modifications for heat pump use are simple and inexpensive.

USE COUPON BELOW TO GET FULL FLOW-THERM DETAILS

- ☆ *Simplifies engineering*
- ☆ *Makes estimating accurate*
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- ☆ *Balanced, proven components*
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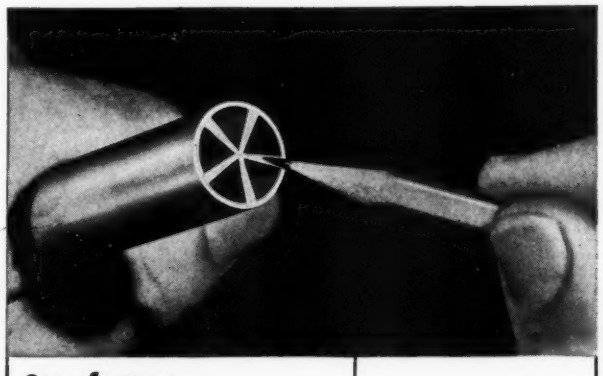
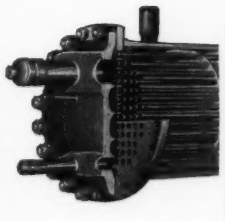


Star feature —

of the new Acme Dry-Ex — key component of the Flow-Therm —is a new copper tubing with a star-shaped aluminum insert* that more than doubles the heat transfer surfaces. Tubes extend straight through to multi-pass heads at each end. No bends, no soldered joints — no leaks!

*Patent applied for



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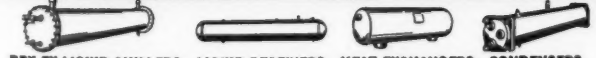
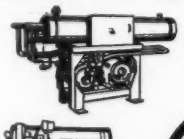


DRY-EX LIQUID CHILLERS • LIQUID RECEIVERS • HEAT EXCHANGERS • CONDENSERS



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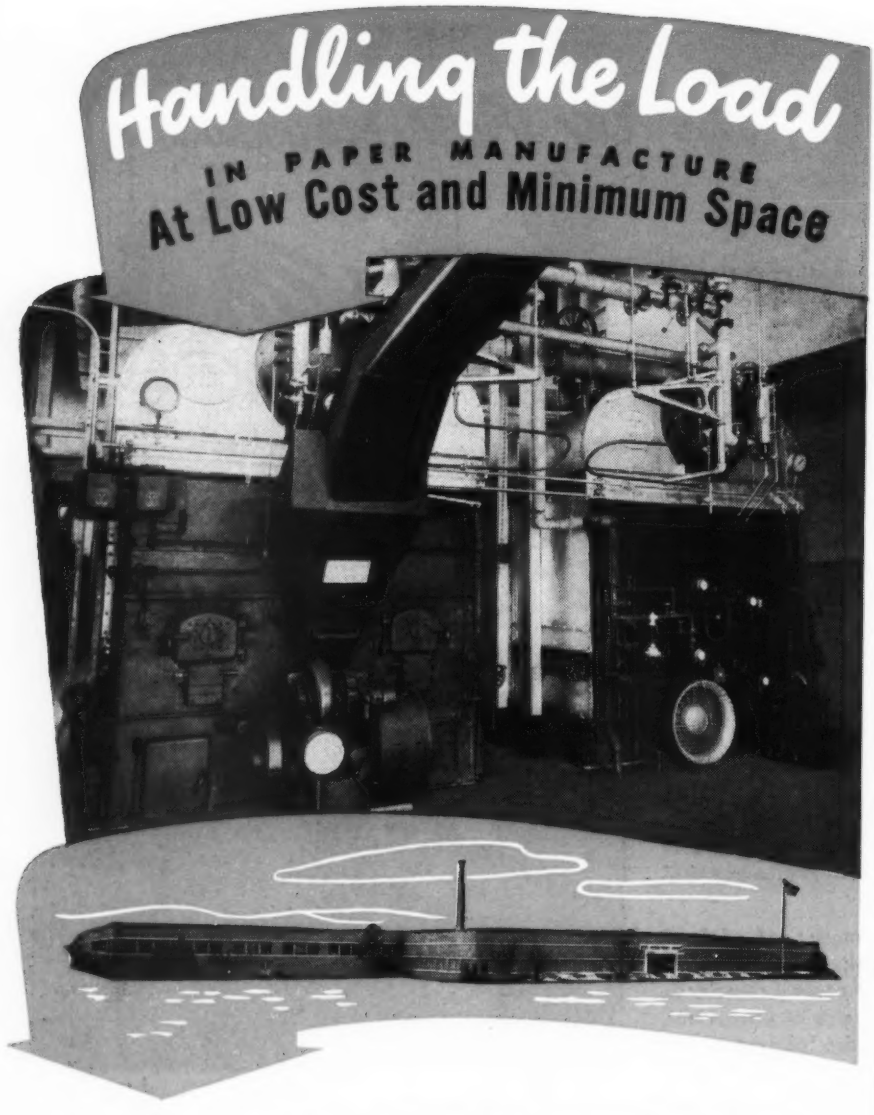
State.....

Manufacturers of Quality Air Conditioning and Refrigeration Equipment since 1919



TITUSVILLE TICOTHERM

STEAM GENERATORS

For Paper Manufacturers Company, at their Bustleton, Pa. plant, two main types of firing are handled efficiently by these Titusville TICOTHERM Steam Generators. No. 1 boiler has a ram-type underfeed stoker, No. 2 is equipped with oil burner for standby, providing flexibility for all processing and heating needs of the large plant pictured.

Write for your copy of informative Ticotherm Bulletin B-3250A —sent promptly on request.

A division of Struthers Wells

THE TITUSVILLE IRON WORKS COMPANY
TITUSVILLE, PA.

***Manufacturers of* A Complete Line of Boilers for Every Heating and Power Requirement**

motion machines can be reduced to one common principle by clearing away the nonessential, obscuring, and mysterious details. That principle implies a machine in a closed system with two unequal forces directly opposed and the weaker force overcomes the stronger one. This is a self-contradiction; it simply makes nonsense rather than a violation of any law of nature.

We wish also to refer to another article in the same issue on page 100 under the heading "Notes From Abroad." It states that the dam at Adaminaby, Australia will hold enough water to shift the center of the earth (theoretically at least) by a quarter of an inch. This seems so preposterous that it prompted a little calculation.

In round figures, the mean radius of the earth is 6.4×10^8 cm and one quarter inch is 0.64 cm. The ratio of the Archimedian lever is then 10^9. The earth is hung on the end of the short arm while the water behind the dam is at the end of the long arm. The two moments must balance if the statement is true. The mass of the earth is given as 6×10^{27} grams (Enc. Brit.). Therefore the mass of water at the dam must be $6 \times 10^{27} \div 10^9 = 6 \times 10^{18}$ grams. To bring this figure within reach of the imagination we will compare it with a cubic mile of water, which weighs 4.2×10^{15} grams. Then the volume of water behind the dam is $6 \times 10^{18} \div 4.2 \times 10^{15} = 1430$ cubic miles. Since the entire annual flow of the Mississippi river is only a few cubic miles, the absurdity of the estimated dam capacity is evident.

It is unnecessary to point out that inadvertent slips like these are rare — and therefore conspicuous — in a magazine of the high caliber of CONSULTING ENGINEER, but they ought not to go unnoticed.

Harvey S. Pardee
Consulting Engineer
Sunland, Calif.

Sir:

CONSULTING ENGINEER is out of this world! Even, further, it is out of this universe! This orderly universe, that is, this cosmos, where things do not happen without sufficient cause...

Let the following simple test be made, using the hitch described (but I would suggest the use of an inert load rather than the one illustrated on page 55); with, say a 100 lb load suspended, let the latch be operated, measuring the force required for withdrawal and the distance through which it operates. Let the load drop only a very short distance

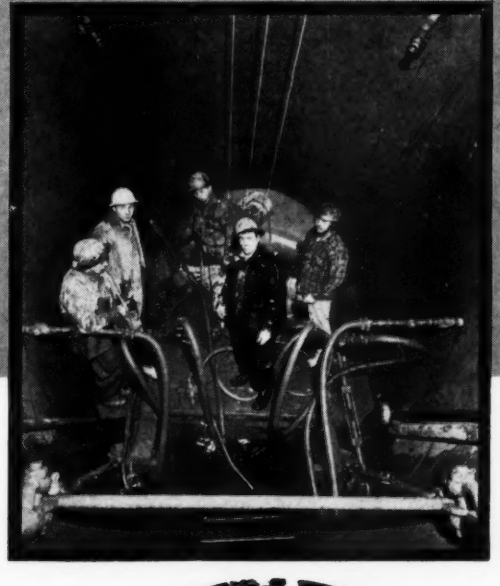
Prepakt Encases ¾-Mile Penstock at Kemano

Some 3,900 feet of steel penstock lining have been encased with Prepakt Concrete at Kemano, B. C. There, the Aluminum Co. of Canada, Ltd., has built the world's largest underground hydro power plant.

Prepakt preplaced coarse aggregate in annular space between steel penstock and excavated rock outline, then consolidated this by pumping Intrusion Mortar. The result—an integral mass of steel, concrete and natural rock to withstand up to 2,600 ft. head of water. Prepakt Concrete, with no setting shrinkage, assures *complete*, monolithic encasement with no after grouting needed.

At Kemano, Prepakt placed 19,000 cu. yds. in two 48-degree tunnels, 8,000 cu. yds. in horizontal runs.

General Contractor: Morrison-Knudsen Co. of Canada, Ltd.
Engineers: British Columbia International Engineering Co., Ltd.



Crew inside 11-foot diameter Kemano penstock pumps Intrusion Mortar through steel lining to consolidate aggregate preplaced by gravity.

• • •

Lower 2,000-foot angle section was encased in one continuous lift—21 working days! Simultaneous aggregate placement and pumping of mortar was used in around-the-clock work to encase tunnel at average rate of 24 cu. yds. per hour. Upper sloping section was encased in two lifts of 400 and 800 feet.

For further information on other Prepakt applications, send a request on your letterhead to: The Prepakt Concrete Co., Room 779-Q, Union Commerce Building, Cleveland.

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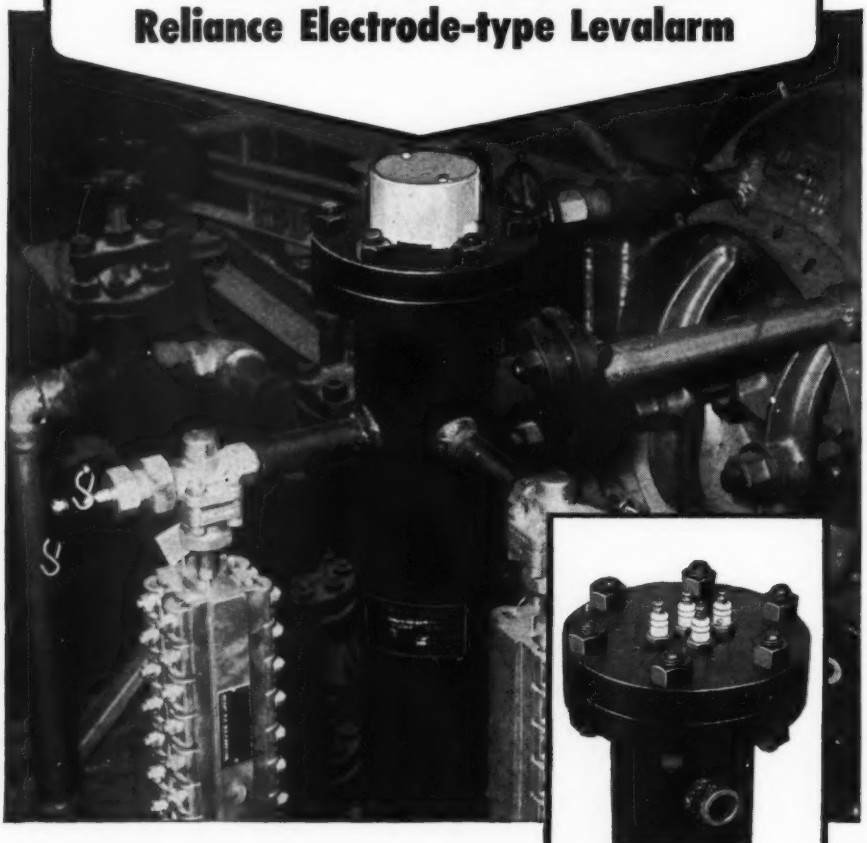
STOCKHOLM • HELSINKI • LONDON • TOKYO • HAVANA

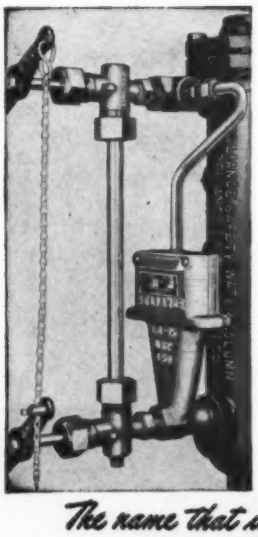
Small Device Does Big Job!

Here's all that shows of the Reliance Electrode-type Levalarm



Cap removed showing electrode connection fittings

Boiler water connects own alarm system and fuel cut-out . . .



Isolated circuits make relays work for you to actuate...

low water alarm — pump start
high water alarm — pump stop
fuel cut-out

(or selection of these facilities)

Upper photograph — Levalarm for pressures up to 1100 psi.

Lower photograph — Fuel cut-out Levalarm on low pressure water column.

Write for Bulletin D2.

The Reliance Gauge Column Company
5902 Carnegie Avenue • Cleveland 3, Ohio

The name that introduced safety water columns....in 1884

Reliance

BOILER SAFETY DEVICES

— say 0.1 inch. Then let the hitch be re-energized, again measuring the force and distance required for the insertion of the ferrite member. If the total of the two operations described is less than 10 inch-pounds, will the 100-lb load actually be picked up and returned to its initial position? If it is, then perpetual motion has been achieved; if it is not, then the laws of conservation of energy have once more been vindicated!

Marshall E. Parker P. E.
Consulting Engineer
Houston, Texas

Sir:

Congratulations on your very excellent coverage of permanent magnets and the practical, useable information on applications using the Ferrite type magnets.

We would like to provide both our design engineers and sales engineers with copies of the article because of the valuable information it contains.

H. G. Swambat
The Indiana Steel Products Co.
Valparaiso, Ind.

Highway Accidents

Sir:

In your July issue, in Economic News Notes, you call attention to the number of fatal accidents, about 78 percent occurring on straight and level roads.

It is interesting to point out that F. W. Giffin, Chief Engineer, New Jersey Highway Authority, who was responsible for the design and lay-out, as well as construction of the New Jersey Garden State Parkway, limited as far as practical, to one half mile, the maximum distance the Parkway could be seen from any one point. This was accomplished largely by both horizontal alignment as well as vertical alignment to overcome the driver hypnosis. Generally, it is impossible to see the Garden State Parkway for miles ahead with the urge to speed to get there, but the continually changing vista, due to the curvature and the rolling grades, and with the generally wide, where practical, median island, has resulted in a highway with low accident rates and a pleasing roadway to use.

F. E. Harley
Wyckoff, N. J.

Uh . . thanks

We all read your magazine and think it's very very good—you must have a good staff.

William W. Brewer
Consulting Engineer
San Francisco, California

If you had this

you wouldn't have this...

SAVE DOLLARS BY SAVING WATER

Yes, in modern industry, wasted water means wasted dollars. By making it economical to re-use and recirculate water, Fluor Cooling Towers allow industry to derive maximum benefits from existing supplies and even to expand operations without seeking additional sources of cooling water. Fluor towers also make it possible to locate plants and facilities most economically *... where you want them ...* rather than at less favorable sites dictated by water availability.

A Fluor Cooling Tower is often the effective solution for one of the most serious problems that a company can face: *water shortage.* Ask an experienced Fluor District Sales Engineer to meet with you to discuss recirculating efficiency and modern methods of saving dollars by saving water.

Send today for our newest brochure: "FACING WATER COSTS"

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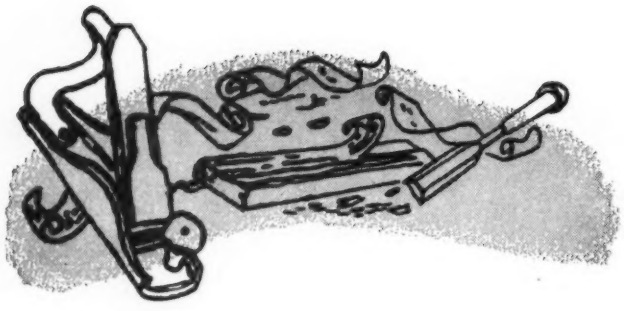


SCRAPS & SHAVINGS

THE EFFORT to enlist engineers in unions is moving along at a pace that must be gratifying to union leaders. The most recent, concentrated organizing effort with which we are familiar is that of the American Federation of Technical Engineers (AFL), in Texas. National President of this union is Russell M. Stephens, P. E., whose office is at 900 F Street, N. W., Washington, D. C. Vice President is J. Lawrence Raimist, C. E., P. E., of the same address.

Since April, these "Professional Engineers" have been writing letters to "Dear Fellow Engineering Employees" and "Dear Sirs and Brothers" throughout Texas. They have been backed up in their efforts by Curtis C. Luttrell, (sans P. E.) of Local 148 (the Local in New Orleans) and Lester Graham, (also sans P. E.) Regional Director of the American Federation of Labor, in Fort Worth, Texas. Mr. Graham supplied all the "Sirs and Brothers" with reprints of an article "Engineers Need Unionism," by-lined by no less than George Meany, himself, while Mr. Luttrell offered encouragement from a neighboring state.

One of the most interesting aspects of this correspondence is in connection with a letter of May 17, from Mr. Raimist, C. E., P. E., the National Vice President. Mr. Raimist wrote the "Sirs and Brothers" a long, 2-page letter, but even at that, he forgot to include everything—so he added a post script.

"P. S. — Through error some of your communications went to the wrong address — so please fill out the enclosed which are already self-addressed and stamped. —J. L. R."

The "enclosed" consisted of a post card headed "Authorization For Representation," and anyone who signed it would find that he had joined the AFL.

Maybe there is really nothing wrong with this little piece of strategy, for anyone who is playing footsy with the AFL to the extent that he does not want any of his communications to go astray probably means to become a union member. Or if he is dumb enough to sign the card without reading it, he surely needs either a union or a guardian to handle his affairs.

There is, of course, nothing sinful about union membership. In fact, George Meany's article gave some good, logical reasons for employee engineers joining a union. The basic reason is the perfectly obvious one: while engineering graduate starting salaries are high, average salaries for experienced engineers are quite low. The unions promise to change this, and their record of accomplishment is not bad.

Most of us agree, however, for reasons expressed many times in CONSULTING ENGINEER and elsewhere, that the way toward professional recognition and higher income levels for engineers is not through union membership. If we accept this as a true premise, we cannot but be disappointed at the recent success of the unions in organizing engineers.

Many engineers indicate not only disappointment but surprise. There should be no surprise. It was through concerted efforts over the past few years that this recent and enormous growth of engineers unions has come about.

Under the Wagner Act, engineers were not permitted to organize separate unions in any plant in which there was a union representing the employees in general. Therefore, if they belonged to a union at all, it was, generally speaking, a trade union. Some few engineers were forced to join these trade unions in plants in which there was a closed or union shop.

Quite correctly, and in all sincerity, the Founder Societies and the National Society of Professional Engineers took up the cause of these few engineers who were unwilling members of trade unions. Finally, with the passage of the Taft-Hartley Act, they were able to have a section approved that eliminated engineers from enforced membership *and allowed them to organize separate unions of their own.* Unfortunately, recent history proves that it was not so much unionism that engineers opposed, but trade unionism. They just did not want to be in the same union with plumbers, steamfitters, and boiler operators . . . a sort of class snobbery.

Given the legal right to organize their own *Professional* unions, they jumped at the opportunity. The result is an enormous paradox in which the successful lobbying efforts of EJC and NSPE resulted in tens of thousands of engineers joyfully joining unions while a few hundred were permitted to escape.

The paradox is emphasized by the realization that under the Wagner Act (a pro-labor act) only 3 percent of the engineers indicated any interest in union membership; but today, under the Taft-Hartley Act (a pro-management act) nearly a third of all engineers feel that union membership would be advantageous to them.

Selection of high-bay mercury lighting answers need for long-range power economy

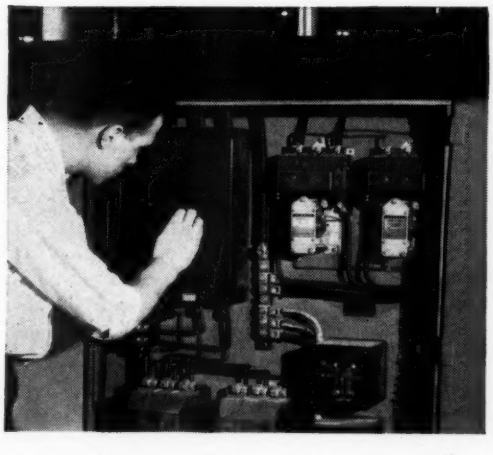
Pontiac's decision to use ventilated high-bay mercury lighting in its new press plant means this:

Better quality control—under any production setup—as well as long-range power economy.

Probably the world's largest 1000-watt mercury lighting installation, Westinghouse luminaires provide an average of 60 footcandles for the 440,000-square-foot production area. Yet the lighting consumes only 3.3 watts per square foot.

And these rugged Westinghouse units are virtually maintenance free. Air circulating through an opening between the neck and reflector sweeps the reflector surface clean—exceptionally practical when you consider the mounting height is 40 feet above the production area. DP-5016-E

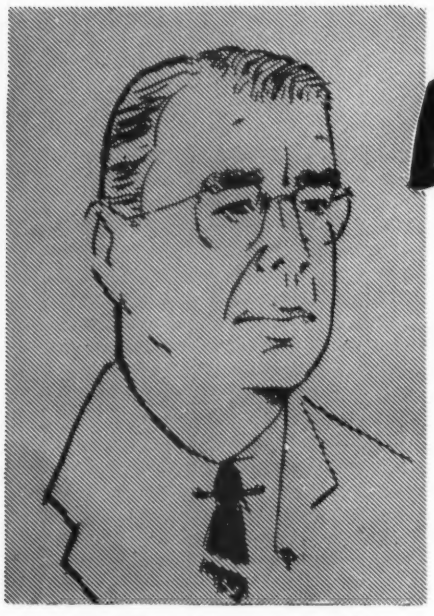
YOU CAN BE SURE...IF IT'S Westinghouse



Westinghouse control board automatically switches over from mercury to stand-by lighting whenever electrical faults may occur. Once the power is restored, a timing relay holds on the stand-by lighting for the duration of the mercury preheat cycle.

1290 Westinghouse ventilated high-bay luminaires deliver 60 footcandles to the working area—over 40 feet below. The aluminum high-bay reflectors shield the mercury lamps from observers through a 32-degree angle zone.

Architects and Engineers: Albert Kahn Assoc., Detroit, Mich.
Electrical Contractor: J. Livingston & Company, Inc., Detroit, Mich.



Economic News Notes

E. F. Mac Donald
INDUSTRIAL ECONOMIST

ANOTHER RECORD — American industry plans to step up spending for plant and equipment in the final quarter of this year. Although actual outlays of $7.3 billion will be under the $7.7 billion total in the 3rd quarter of this year, they will, when seasonally adjusted, be at an annual rate of $29.7 billion — the highest rate in history. The estimated total for all 1955 will be 4% more than last year and 3% more than was scheduled at the outset of this year. Railroads in particular have exceeded their earlier plans, spending 20% more than they had expected to this year.

CONSTRUCTION CHANGE — In five more years, predicts Mr. G. K. Iwashita, general manager of GE's air-conditioning department, practically all new factories built will be equipped throughout with air conditioning. This will be a big change since, as he points out, only 15-20% of current new industrial construction is air conditioned. This will mean a terrific number of projects for consulting engineers.

PLANT SITES — The September 12 issue of The Journal of Commerce carried the 3rd Quarterly 1955 "National Plant Location Survey," listing 1,500 sites in 46 states suitable for chemical or allied industries. Location for each site by state and city was listed as well as acreage, water supply and source, and starting rate for unskilled labor. A survey of vacant plants in Maryland was included in the September News Letter of the Maryland State Planning Commission.

SERIOUS PROBLEM — An increasing economic problem, weighing more and more heavily as a key industrial location factor, is availability of an adequate supply of water. Experts in the Department of Commerce estimate that over $25 billion of water and sewerage facilities will have to be provided in the next decade to meet requirements. The President's Materials Policy Commission warns that in 20 years, availability of satisfactory water may become "the most important factor in deciding where to locate industry." The water problem seems to merit even more concern and attention than is being given it by industry and public bodies.

PORT IMPROVEMENT — Funds are in hand for digging a shorter and more direct channel to the upper Cooper River docks, at Charleston. The South Carolina port, well into an expansion and modernization program, will have within a year two channels for its growing traffic of shipping from all parts of the world.

NO MEANDERING — And on the subject of water — work has begun to thwart the Mississippi's attempted "end run" around New Orleans. In recent years, the Old River has been flowing out of the Mississippi River in increasing volume, upstream from New Orleans, threatening to effect a complete diversion of the Mississippi. The $47 million, 8-10 year project to keep the Mississippi in it proper channel is vital to the economy of New Orleans and the whole Lower Mississippi Basin.

BUILDING FACTOR — Between 250,000 and 300,000 dwellings are taken out of the residential market every year by demolition, condemnation, and in other ways, according to a recent estimate of the Bureau of Labor Statistics. Previous estimates were far under this — around 40,000 to 50,000 only annually.

COMPROMISE PLAN — Senator Kuchel (R-Cal) plans to introduce in the next session of Congress a $32 billion, 12-year Federal highway-building program. He proposes to finance the project by increasing taxes of road users and by the sale of U.S. bonds.

THROUGH THE TRANSIT — AEC will build a $10 million headquarters near Germantown, Md., about 20 miles from D.C. . . . . Eye-Catcher — The new civic coliseum in Charlotte, N.C., with an aluminum, dome-shaped roof and a 13,500 seating capacity unobstructed by pillars . . . . The building boom continues at Miami Beach with two large hotels and three, million-dollar-class motels. This fabulous strand is fast getting geared to a high prosperity-level economy . . . . Construction of shopping centers also continues on a high level. R. H. Macy & Co. is starting construction of a $10 million center in Bergen County, N.J. It plans to expand the center later on. In the same fast-stepping county, Allied Stores is getting ready to build "the biggest [shopping center] in the world." . . . . Disabling injuries in construction last year amounted to 17.3 per million man-hours worked . . . . Fabulous U.S.A. — Total public and private debt (12/31/54) amounts to $606 billion — $12,923 for every family . . . . Jones & Laughlin will construct a plant on a 31-acre site in Willimantic, Conn., for production of cold steel bars — right handy to users of cold finished steel bars such as the machine tool and screw machine industry . . . . The opening of the Ohio Turnpike this month leaves only two gaps in the thru-expressway from New York to Chicago — the connection between the Pennsy and the New Jersey turnpikes, and the Indiana Pike.

There's Steam Economy in FLEXIBILITY

Above, six Erie City Keystones meet a variable heating and processing steam load at the Ohio Masonic Home in Springfield, Ohio

JOSEPH BRESLOVE
& ASSOCIATES
CONSULTING ENGINEERS
CLEVELAND, OHIO

Picture the boiler operating advantages of multiple Erie City Keystone Steam Generators in your plant. Multiple "Keystones" permit high efficiency operation. During periods of low loads, take one or more units off the line—for high loads, the rapid steaming "Keystones" respond quickly to increased requirements.
Compact, completely factory assembled and Factory Fire Tested "Keystones" fit into any plant's variable steam needs.
There is nothing to assemble in the field.
Need steam at some remote plant location indoors or outdoors? Investigate the use of one or more "Keystones." Bulletin SB-51 describes the fully automatically controlled Keystone.

ERIE CITY
15 Years in Steam Generation

You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

ATOMS IN ACTION

PROCEEDINGS OF THE GENEVA conference will be published by the United Nations in a 16 volume set. The set will include all papers, whether presented orally or in written form, together with a record of the discussions concerning each paper. For orders received up to December 31 price is $110 for the set. Individual volumes will also be available but no price has been decided on. United Nations Headquarters Bookshop is taking orders and the books are expected to be ready early in 1956.

AS EXPECTED, a great deal of formerly hush, hush information on how far each of the leading nations has progressed in development of atomic energy came out at the Geneva Conference. This is the way these nations stack up as to power plant development: the U. S. now has ready for construction two nuclear power plants that would be economically feasible in some parts of the world — the pressurized water reactor and the boiling water reactor — and two more that are probably feasible — the sodium graphite reactor and the uranium graphite reactor. This does not include research reactors or experimental reactors of the fast breeder and homogeneous types. The United Kingdom has one type, the gas cooled, uranium fueled, graphite moderated reactor to be constructed at Harwell. They plan to develop a water moderated type as soon as the Calder Hall reactor is ready to be turned over to industry. The U.S.S.R. claims to have in operation a 5000 kw power plant of the uranium and graphite type cooled by pressurized light water, a 600 kw-heat heavy water reactor plant, and a materials testing reactor and a low power level research reactor. Under construction they listed a 100,000 kw power plant consisting of two 2,000,000 kw-heat graphite moderated, enriched uranium reactors and both light and heavy water research reactors. If the 100,000 kw power plant is completed in 1956, as Russia claims, it may well be the first full-scale atomic power station in the world.

THE FUSION-FOR-PEACE program elicited two interesting comments this month. Senator Clinton Anderson, Chairman of the Joint Congressional Committee, speaking before the Cleveland Rotary Club, said "Today, only a handful of our finest scientists are working on the problem of controlled hydrogen energy. Our annual per capita spending in the controlled hydrogen field amounts to less than the price of one package of cigarettes." (On the basis of 165 million people and 20c a pack, this would be $33 million a year). In a televised panel discussion at a later date AEC Chairman Strauss said that the program is "not being stinted in any way," and that "we are spending as much money as those engaged in the work have asked for." Strauss also pointed out that money and manpower had been increased "more than 1000 percent in the last two years."

SIDELIGHTS OF THE CONFERENCE . . . Five days after the close, General Electric announced that more than 15 different foreign firms and organizations had inquired as to whether G.E. could build atomic reactors for them . . . The nuclear reactor to be built by Westinghouse for the Shippingport power plant will have "designed-in safety factors," according to a paper presented by Dr. S. Kasik and Dr. A. Radkowsky. They described it as a "negative temperature coefficient" — as the temperature of the reactor increases, fissioning decreases . . . The Joint Congressional Committee on Atomic Energy held executive hearings at Geneva to determine, among other things, if the U. S. Act of 1954 was inhibiting U. S. businessmen in their foreign contacts. They concluded that the law is very good as it is.

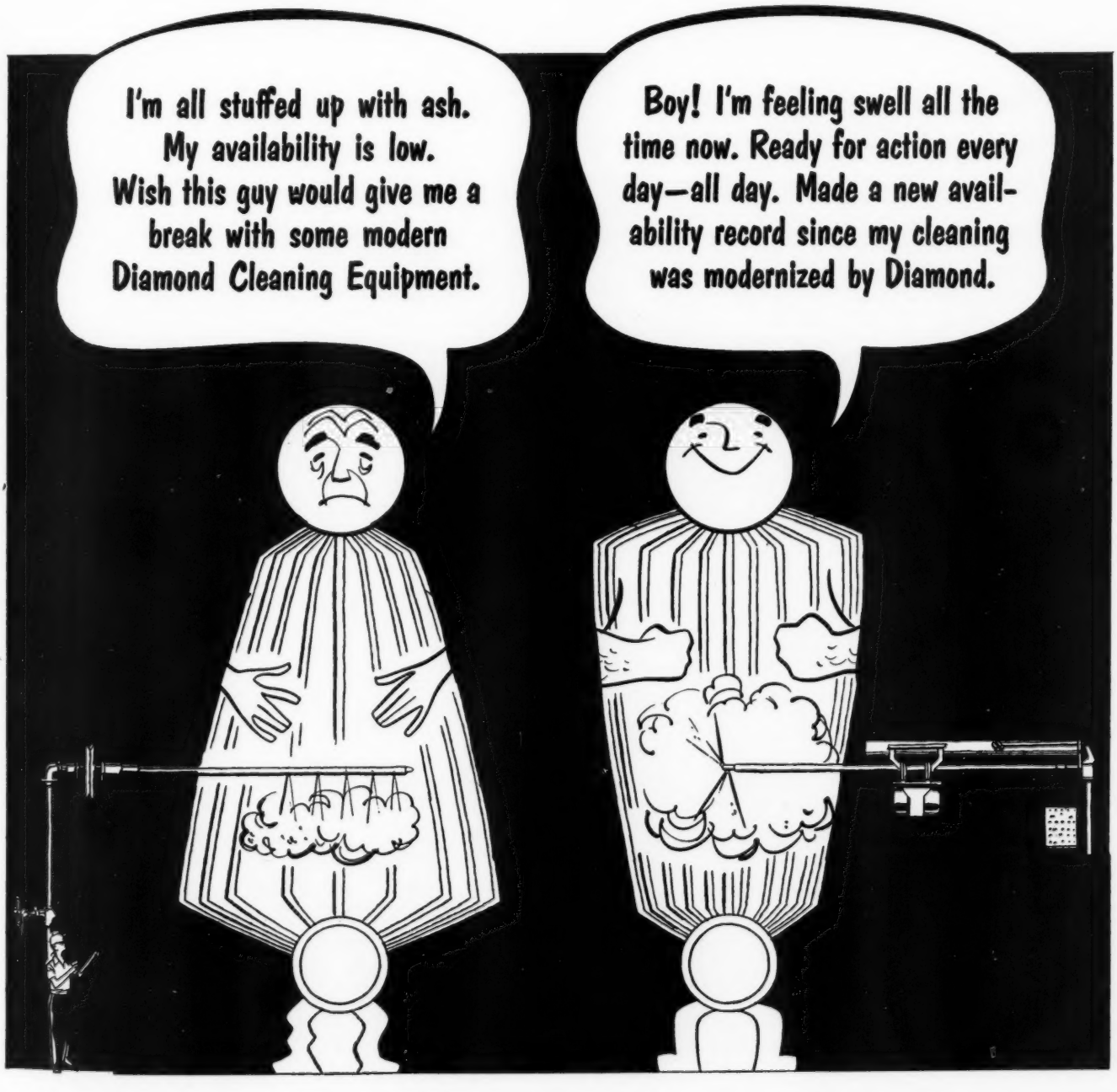
CONCRETE, whose high density makes it particularly suitable for shielding, has been developed by Victor Chemical Works. Incorporation of an alloy of iron and phosphorus, called ferrophosphorus, is responsible for the high density — 290-300 lb per cu ft.

COMBUSTION ENGINEERING, INC. has been awarded the design and development contract for the Submarine Reactor Small (SRS) project by the Atomic Energy Commission. The contract calls for design, manufacture, assembly, and test of a reactor and related equipment suitable for propulsion of a small submarine, with the firm bearing 25 percent of the research and development costs up to a maximum of $3 million. Up to now, Westinghouse and General Electric had the submarine reactor field to themselves. Award of this contract to Combustion Engineering seems to be part of an AEC policy to broaden the industrial base of reactor-building know-how.

THE AEC HAS APPROVED, as bases for negotiation, two of the four proposals made under its power demonstration reactor program: Commonwealth Edison — Nuclear Power Group, Inc. and Detroit Edison Co. and associates. Yankee Atomic Electric Co. and Consumers Public Power District, whose proposals were not accepted, are understood to have submitted modified proposals which AEC now has under consideration. Membership in the Detroit Edison group has been increased to 23 companies with the addition of Columbus & Southern Ohio Electric Co., Combustion Engineering, Inc., and Westinghouse.

THE FOREST PRODUCTS LABORATORY of the U. S. Department of Agriculture has developed a low cost building board called "diffusion board" that is impervious to poison gases and particulate matter including radioactive fallout but which easily passes oxygen and carbon dioxide. The new product can be made with standard fiberboard manufacturing equipment from any species of wood.

Modernize Boiler Cleaning to IMPROVE AVAILABILITY


I'm all stuffed up with ash. My availability is low. Wish this guy would give me a break with some modern Diamond Cleaning Equipment.
Boy! I'm feeling swell all the time now. Ready for action every day—all day. Made a new availability record since my cleaning was modernized by Diamond.

DIAMOND POWER SPECIALTY CORPORATION

LANCASTER, OHIO

DIAMOND SPECIALTY LIMITED, WINDSOR, ONTARIO

7209

the Legal Aspect

MELVIN NORD
Consultant in Legal and Technical Problems
Registered Professional Engineer
Patent Attorney

. . . The Effect of Legislation on Labor Law (II)

TO MANY PEOPLE, the words "Taft-Hartley" are considered dirty words, while to others they are practically sacred. It is not likely that many of those who have the strongest opinions have read the Act. In fact it is not even likely that they are aware of the fact that the 1947 Taft-Hartley Act is basically only an amendment to the National Labor Relations Act, tending to correct the previous "over-correction" of the N.L.R.A.

Employer Unfair Labor Practices

The following activities by an employer continue to be prohibited: (1) interfering, restraining, or coercing employees in the exercise of their right to organize and bargain collectively, (2) dominating or interfering with the formation or administration of a labor organization or contributing financial support to it, (3) discriminating in employment to encourage or discourage membership in a union (except in accordance with an agreement with the union for a union shop or a closed shop), (4) discharging or discriminating against an employee because he has filed charges or given testimony against the employer, and (5) refusing to bargain collectively with the employee's bargaining agent.

While the Taft-Hartley Act does not repeal item (1) above, it greatly weakens it by providing as follows: "The expressing of any views, argument, or opinion, or the dissemination thereof, whether in written, printed, graphic, or visual form, shall not constitute or be evidence of an unfair labor practice . . . if such expression contains no threat of reprisal or force or promise of benefit." Previously, such threats, etc., were very readily implied, to the extent that it was extremely dangerous for the employer to say anything whatever concerning labor problems to an employee.

In connection with item (3) above, the Taft-Hartley Act in essence provides that an agreement with a union for a union shop or closed shop is not binding unless a majority of the employees eligible to vote have voted to authorize such an agreement.

In connection with item (5) above, requiring collective bargaining, the Taft-Hartley Act provides that neither employer nor union need bargain collectively if the other has terminated or modified the contract without giving 60 days notice prior to the expiration date. Furthermore, the terminating party must offer to meet with the other party to negotiate a new contract, must notify the Federal Mediation and Conciliation Service (which was established by the Taft-Hartley Act), and must not resort to a strike or a lockout during the 60 day period. Any employee who engages in a strike within the 60 day period loses his status as an employee, under the Taft-Hartley Act. Thus, the general requirement of bargaining collectively continues, but the addition of a "cooling off" period gives management some new ways of avoiding or at least postponing collective bargaining.

Union Unfair Labor Practices

Paralleling the N.L.R.A.'s list of employer "unfair labor practices," the Taft-Hartley Act has added a number of union "unfair labor practices." These include the following: (1) restraining or coercing employees from exercising their right to join or refuse to join a union, (2) causing or attempting to cause an employer to discriminate against an employee (except in accordance with an agreement with the union for a union shop or a closed shop), or discriminating against an employee to whom membership in the union has been denied or terminated for any reason other than failure to pay dues or uniform initiation fees, (3) refusing to bargain collectively with the employer, (4) forcing an employer or self-employed person to join a union, by threat of a strike or a boycott, (5) forcing an employer to refuse to deal with another person, by threat of a strike or a boycott, (6) forcing an em-

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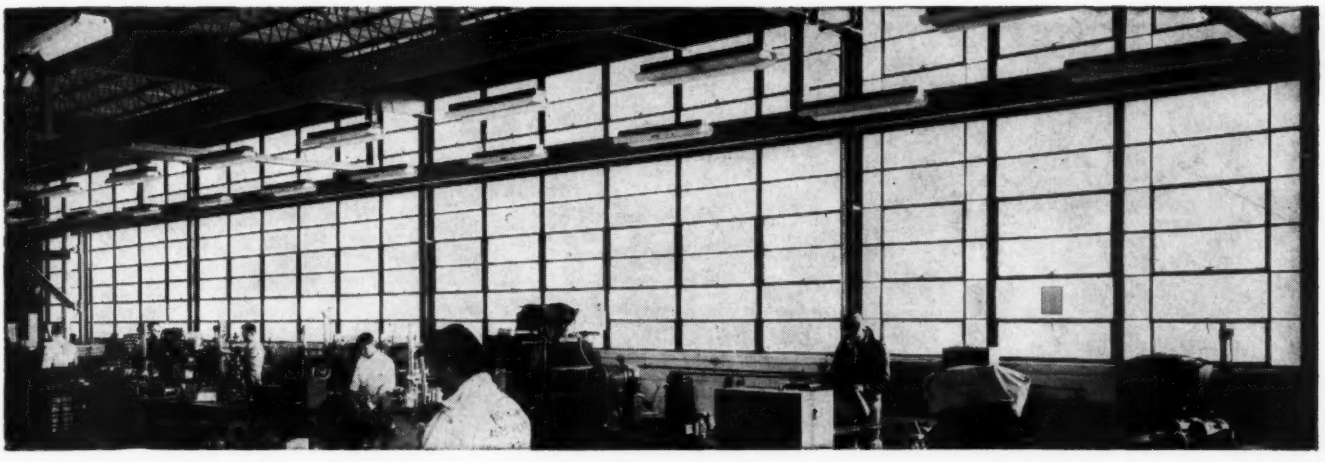

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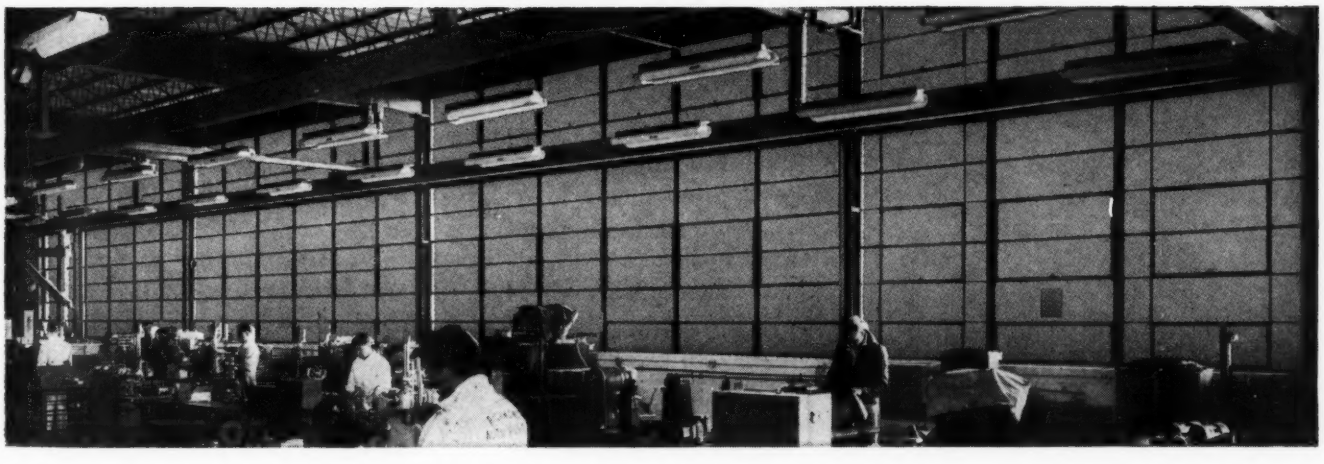

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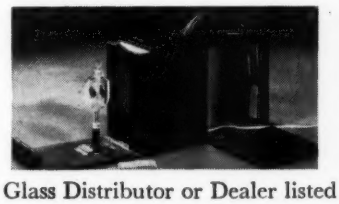

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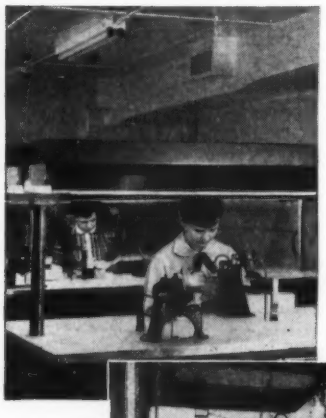

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ployer to recognize a union which has not been properly certified as the employee's representative, by threat of a strike or a boycott, (7) jurisdictional strikes or boycotts, (8) requiring an excessive or discriminatory initiation fee, where there is a union shop or a closed shop, (9) "featherbedding," i.e. requiring the employer to pay for services not actually performed.

Thus, jurisdictional strikes, secondary strikes, secondary consumption boycotts, and featherbedding have been outlawed, and some other abuses have also been corrected. Many other questions, however, continue to remain unsettled, i.e. they must be decided by case law.

Representatives and Elections

The Taft-Hartley Act continues the general provision regarding certification of unions as bargaining agents of employees, but permits an employee individually to present grievances to the employer, provided the bargaining representative has been given an opportunity to be present. The Taft-Hartley Act permits groups of professional men to refuse to be represented in a union containing non-professional men, and it also requires that persons hired as guards to protect the employer's property shall not be included in unions along with employees other than guards. It is also provided that employees on strike who are not entitled to reinstatement (e.g. those who have engaged in a strike within the 60 day period) cannot vote in an election, so that in case a union violates this provision, it may quickly find itself voted out by employees who have not struck. This provision obviously is not regarded favorably by unions. It is analogous to saying that any corporation that violates a law shall have its charter revoked, — which might be a good idea in some cases, but would not be received very enthusiastically by corporations.

Under the Taft-Hartley Act, independent contractors are not employees, and neither are supervisors. A supervisor is defined as "any individual having authority, in the interest of the employer, to hire, transfer, suspend, lay off, recall, promote, discharge, assign, reward, or discipline other employees, or responsibility to direct them, or to adjust their grievances, or effectively to recommend such action, if in connection with the foregoing the exercise of such authority is not of a merely routine or clerical nature, but requires the use of independent judgment." This does not quite eliminate everyone from the status of employee. This does not mean that supervisors cannot belong to a union, but the employer need not regard them as employees within the meaning of any part of the Act.

Voting under the Taft-Hartley Act is by secret ballot, when a bargaining agent is being elected.

The Taft-Hartley Act provides that the Labor Relations Board shall not act in response to a request by a union unless the union has filed with the Board detailed information, including (1) the names and compensation of officers or agents receiving more than $5000 per year in salaries and other allowances, (2) the manner in which such officers or agents were elected, (3) initiation fees and dues, and (4) detailed statements of the mode of "doing business," — e.g. imposition of fines, authorization for strikes, audits, insurance plans, etc., — and unless it has filed with the Secretary of Labor and furnished all members of the Union a report showing (1) all its receipts and their source, (2) its total assets and liabilities, and (3) all the disbursements made by it. Then, to top it off, the union is also required to file with the Board an affidavit by each officer that he is not a member of the Communist Party.

If one were to seek an analog of this as respects corporations, one would probably require them

to exercise affidavits to the effect that they have never been guilty of bribery, extortion, sodomy, or belonging to interlocking directorates, and to disclose any information they might have as to how the corporation makes money. The only justification one can find for provisions such as these would be that one hates the guts of corporations. The justification for many of the provisions of the Taft-Hartley Act cited above are equally as good.

Prevention of Unfair Labor Practices

The N.L.R.A. provides for a hearing by the Board, in case of a claim of unfair labor practice, and this provision is continued in the Taft-Hartley Act. A cease-and-desist order is given by the Board in case it finds that there has been an unfair labor practice. The only change here has been that this procedure is now applicable against labor unions, as well as against employers.

The Board can petition a court to enforce a cease-and-desist or other order of the Board (e.g. reinstatement of an employee). Under the N.L.R.A., the findings of fact of the Board were conclusive on the court. The Taft-Hartley Act reads as follows: "The findings of the Board with respect to questions of fact if supported by substantial evidence on the record considered as a whole shall be conclusive." The result is a regrettable tendency to throw disputes back into the courts.

Similar provisions also allow a party aggrieved by a final Board order to appeal to the courts.

Injunctions were available against employers under the N.L.R.A., after an order had been promulgated by the Board. These are now also available against unions. However, injunctions obtained in this way are not available for a considerable time. Therefore, the Taft-Hartley Act further provides that the Board can obtain by petition from a court a temporary injunction practically immediately upon is-

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suance of a complaint by an employer or a union that there has been an unfair labor practice (actually following a preliminary investigation by an agent of the Board). It is even provided that these temporary injunctions can be made *ex parte* in some cases, thereby virtually nullifying the Norris-LaGuardia Act. While some "brakes" are still provided against the issuance of temporary injunctions, the evils which the Norris-LaGuardia Act sought to avoid have been invited back in again through a rear door.

Other Taft-Hartley Provisions

The Taft-Hartley Act also provides that in case of a national emergency, (i.e. where a strike will imperil the national health or safety) the President, upon receiving a report from a Board of Inquiry, can petition a court for an injunction. It also provides for the compilation of all collective bargaining agreements, which file is readily available and open to public inspection.

The Taft-Hartley Act regards labor unions as legal entities, subject to suit, and provides that judgments collected against a union may be collected from it as an entity. This is a new concept and, though perhaps hateful to the unions, a good one. Now there are two parties to a labor contract, not just one.

The Taft-Hartley Act requires written authorization of an employee before his union dues can be deducted from his wages. This constitutes a slight interference with the union's check-off system.

The Taft-Hartley Act also prohibits corporations and labor organizations from making contributions or expenditures in connection with any election for Federal office. This provision, which seems quite symmetrical on the face of it, as a matter of fact effectively prevents employees from being politically active, while not affecting corporate directors, officers, or stockholders. That is to say, it does so if it is valid and enforceable. This question is now being litigated in the courts.

Summary on Labor Legislation

To summarize, therefore, it can be seen that the Taft-Hartley Act has the appearance of equal-handed justice and symmetry between employer and employee, but is in fact thoroughly anti-labor. To be sure, it has added some needed reforms to the existing law, but it has not done a systematic job of this. And it has added many gratuitous insults and injuries to unions. Every change of any significance has impeded labor unions — sometimes justifiably and sometimes not. No change has benefited labor unions. Looking at it as impartially as one can, one is forced to agree with both of the presidential candidates in 1952, who found the law to be imperfect.

The history of labor legislation thus far has therefore been 100 percent consistent, i.e. consistently unsatisfactory. The Norris-LaGuardia Act and the N.L.R.A. were violently pro-labor. The Taft-Hartley Act is violently anti-labor. Thus, the history of labor legislation has been the same as the history of labor law in the courts, only in reverse. The courts at first were harsh, then easy. Congress has been easy, then harsh.

This may be "good law," but it's a "hell of a way to run a railroad." It's about time labor law were taken out of the realm of fantasy and brought down to earth. There is no reason for labor law to be a political football, any more than contracts law or workmen's compensation law. It's time for labor law to become rational, instead of irrational. This may not be easy, but it can be done if one is willing to take an "engineer-type approach," and disregarding subjective prejudices.

The solution to labor law problems is to pass legislation that is not pro-labor nor anti-labor, but which is objective, impartial, and sound, without fear of or favor to any group. ▲▲

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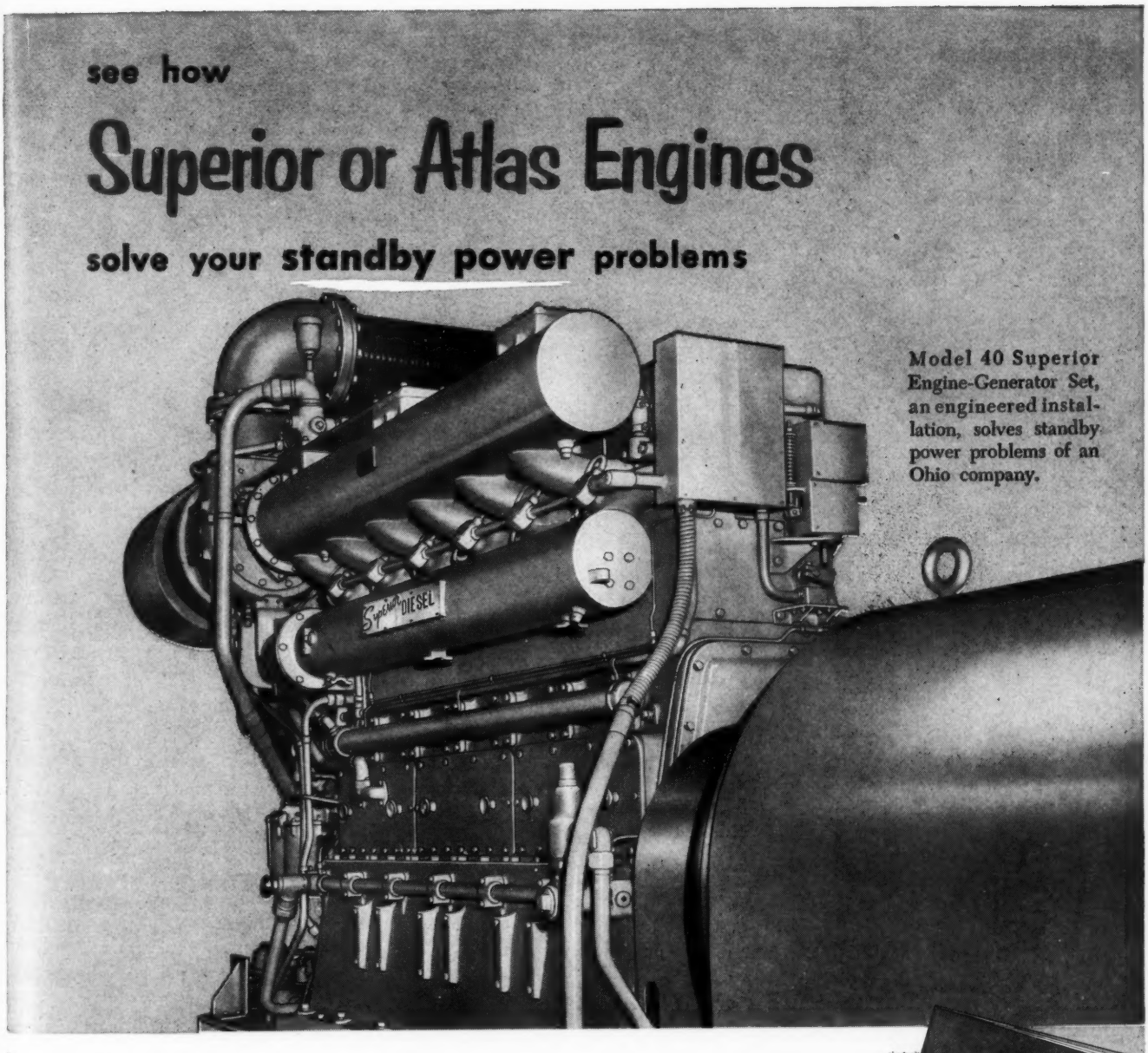

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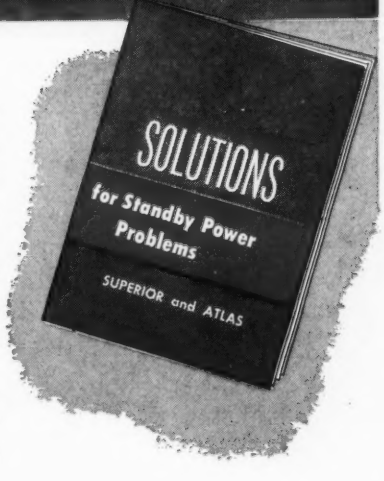

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REPORT FROM HOLLAND

FRITZ D. HIRSCHFELD
European Editor

SEVERAL MAJOR factors that have influenced the development of the Dutch people and their country also characterize the activities and organization of Dutch consulting engineering firms. Because Holland is a small country with a relatively large population, close cooperation and coordination of all segments of the economy has been essential. Because much of the land has actually been reclaimed from the sea, a great deal of attention has been focused on problems relating to hydraulics. And since the Dutch have a long history as traders, commercial enterpreneurs, and colonizers, they have always been international-minded and particularly sensitive to opportunities in the world market.

The Dutch Association of Consulting Engineers is a tightly-knit group with approximately 75 members. They have membership requirements, a code of ethical practices, and fee schedules generally corresponding to those of the other European consulting engineering associations. One wonders, however, if these codes are really necessary in Holland. Most of the engineers are graduates of the Technical University at Delft — the most prominent engineering school in the country. All Delft graduates can be identified by the *Ir* before their names (i.e. in the name, Mr. Ir John Jones, the *Ir* means that he's an engineering graduate of Delft). Either through school or business contacts, Dutch consultants are well-known to each other and, though they work independently, they have strong personal ties. In these circumstances the unwritten rules of friendship often replace the more formal laws of professional ethics.

This cooperative attitude is common to the Dutch way of life. For example, when the Dutch saw an opportunity to pool their engineering talents (public, private, and institutional) in order to be in a better competitive position to bid for development projects in the economically backward areas of the world, they found everyone willing to participate. The Dutch government put up roughly $130,000 to form NEDECO (Netherlands Engineering Consultants) as a private group to export Dutch engineering know-how. Private consultants interested in foreign work became associated with NEDECO. Other specialists and institutions offered to put their facilities at the disposal of the group. It became a truly cooperative effort, and NEDECO, in its four years of existence, has an impressive record of consulting engineering work abroad.

As Americans, we are inclined to be very skeptical of anything that introduces the government into an area that normally belongs to private business. Can you picture the storm that would break in the U. S. if the government were to suggest that American consulting engineers form a private group to handle engineering projects abroad and then offered to finance it. If it happened to be a Democratic Administration, the accusation would be "creeping socialism." Under the Republicans it would probably be called another move in favor of "big business."

In Holland it does not seem to work that way. The government is expected to look after the welfare of its people and to further any projects that will contribute to the Dutch economy, without political ambitions or implications. That is probably why the Dutch can accept the assistance of their government, work side by side with government people, and still be completely independent and individualistic. The well-known phrase, "stubborn Dutchman" is not merely a figure of speech!

Another joint venture between Dutch private interests and the government that has attracted far more publicity than NEDECO is the encouragement of American industrial firms to set up operations in Holland. Shortly after the war, the Dutch realized that many American firms had difficulty in selling their goods in non-dollar countries and were contemplating setting up operations in "soft-currency" areas in order to reach this non-dollar market. "We knew that American firms would set up plants in non-dollar countries sooner or later" says Mr. Ir D. Rens, Director of the Netherlands Industrial Institute, "so we said to ourselves, why not attract these firms to Holland? Even if they compete with our own industries, which they would do no matter where they were located, at least in Holland they could be buying Dutch materials, employing Dutch people, and generally contributing to the Dutch economy." Backed by an excellent labor pool, favorable investment laws, a good location, and other selling points,

Dutch representatives have successfully attracted a substantial number of American firms to open plants or headquarters.

American consultants may be particularly interested in the activities of three of these firms that I visited while in Holland. Mr. K. H. Beekhuis is the American Executive Vice-President of the Aramco Overseas Co., located in The Hague. Aramco Overseas does all the central purchasing and some of the engineering for the Arabian-American Oil Co. interests in the Middle East and other areas in this part of the world. The central purchasing is a tremendous operation involving the procurement of everything from food supplies to engineering equipment for 15,000-18,000 employees working in the oil production, refining, and related operations of the parent company. Because Aramco is obviously interested in buying the best available material at the most economical prices, they have gathered a lot of direct and valuable purchasing data. This intimate background may be useful to American consultants working abroad who are called upon to specify foreign equipment and who may not be so well acquainted with the European market. Mr. Beekhuis and his organization could be helpful.

The tremendous expansion of petrochemical plants in Europe is proving to be good business for American engineers. Dave Parvis is the partner in charge of the Dutch office of Industrial Models, Inc., a Wilmington, Delaware, consulting engineering and model-building organization. Parvis and his group of engineers are consultants to Dutch, French, English, and American companies in the petrochemical field who want to find the most economical piping layout for their plants. Using its own model-making techniques and methods of analysis, Industrial Models is able to recommend design and erection procedures that usually result in substantial savings not only in building the plant

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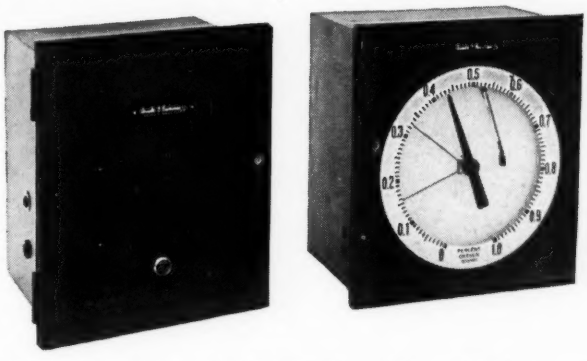

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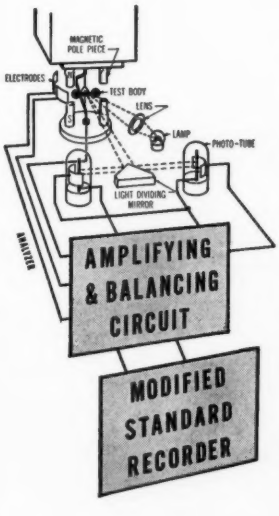

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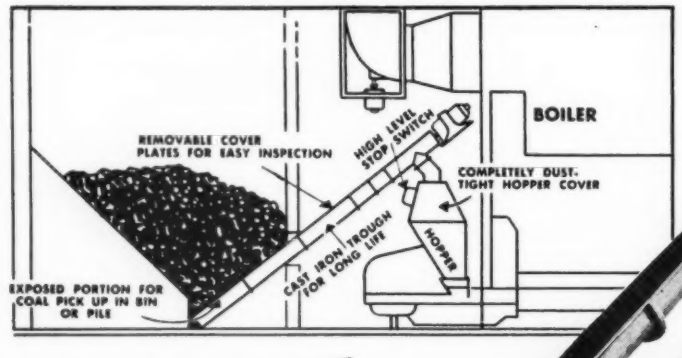
but in bringing it into operation with a minimum of revisions and difficulties. Parvis expects that his office will do an increasing amount of business in Europe. Right now, he tells me, his biggest headache is getting the necessary personnel to carry through these commitments.

The Lummus Co., of New York, are in Europe in a big way. They call themselves consulting engineers and contractors and have offices in Paris, London, and The Hague, employing some 600 people. The Hague serves as headquarters for their European sales engineering activity as well as housing a large engineering and design staff. There's lots of business for Lummus in designing and building petrochemical plants in Europe and there is also lots of competition. The Germans and the Italians offer keen competition in their respective countries, and then there are such fellow-American companies as Kellogg, Bechtel, Fluor, Parsons, Pritchard, and Stone & Webster who are also bidding for European work. By locating in Europe, Lummus is able to offer American techniques at European prices. That, basically, is the reason any American engineering firm locates over here.

Because the Dutch have had to spend so much time and energy fighting the sea — first building dams, then reclaiming the land — and later guarding against floods— they have gained extensive experience and developed detailed techniques for dealing with many problems of this nature. A majority of the Dutch consultants specialize in hydraulic work like irrigation schemes, dredging, coast protection and sea dykes, port and harbor facilities, channel improvements, and related projects. The excellent laboratories, testing, and research facilities that the Dutch government and private institutions have built to solve various hydraulic problems are at the disposal of the Dutch consultants and give them an advantage in this field of engineering.

During Holland's many years as a colonial empire, Dutch engineers have also benefited by work and study in tropical and sub-tropical colonies like Indonesia, Surinam, and in the Dutch West Indies. This experience is proving invaluable.

But the biggest asset of the Dutch and of the Dutch consulting engineers is their ability and willingness to accept the principle of cooperation. NEDECO (Netherlands Engineering Consultants) is the best example. Let me quote from one of their pamphlets: ". . . . cooperation on a national scale enables NEDECO to tackle extensive and complicated projects beyond the capacity and scope of ordinary consulting offices and engineering firms. Moreover, such an association of experts is particularly valuable at the present time, since the progress in science and engineering has made it possible to develop vast regions, raising problems of increasing importance and size which can only be solved by groups of specialists." ▲▲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NUCLEAR PUMP LEADERSHIP

Byron Jackson has either developed, engineered, manufactured... or handled as a complete project... pump equipment for every nuclear reactor in use in the United States.

Write today for the special technical paper "Centrifugal Circulating Pumps and Auxiliary Pumps for Atomic Power Plants" prepared by Carl Blom, vice president and chief engineer (Pump Division). This paper, probably the most authoritative available, was presented at the conference sponsored by Stanford Research Institute and the Atomic Industrial Forum, San Francisco, California in April 1955.

BJ

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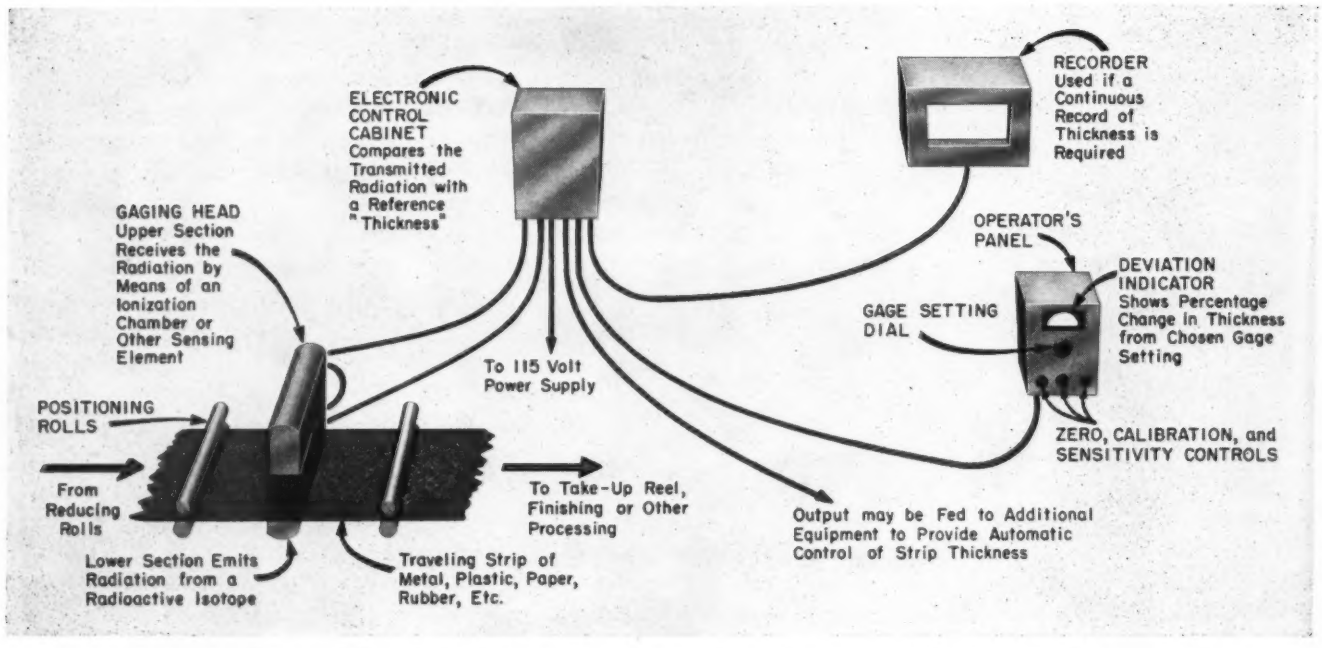

RECORDER
Used if a Continuous Record of Thickness is Required
ELECTRONIC CONTROL CABINET
Compares the Transmitted Radiation with a Reference "Thickness"
GAGING HEAD
Upper Section Receives the Radiation by Means of an Ionization Chamber or Other Sensing Element
OPERATOR'S PANEL
DEVIATION INDICATOR
Shows Percentage Change in Thickness from Chosen Gage Setting
GAGE SETTING DIAL
To 115 Volt Power Supply
POSITIONING ROLLS
ZERO, CALIBRATION, and SENSITIVITY CONTROLS
From Reducing Rolls
To Take-Up Reel, Finishing or Other Processing
Output may be Fed to Additional Equipment to Provide Automatic Control of Strip Thickness
Lower Section Emits Radiation from a Radioactive Isotope
Traveling Strip of Metal, Plastic, Paper, Rubber, Etc.

FIG. 1—SCHEMATIC LAYOUT OF BETA-RAY GAGE USED TO MEASURE THICKNESS OF STRIPS FROM ROLLS.

Can You Afford to Ignore Atomic Energy?

PHILIP D. BUSH, Acting Manager,
Atomic Energy Division, Kaiser Engineers

IN ATTEMPTING to answer the question, "Can an Engineer Afford to Ignore Atomic Energy?", it is apparent that the nuclear power plant phase of the business constitutes an important factor in arriving at an answer to the question. A previous article[1] by the author developed the thought that from both the economic and fuel supply aspects, nuclear power plants will constitute a significant portion of the nation's power capacity by 1980. The engineer's place in the development of this new power source was discussed in that article. However, nuclear power is just one aspect of the engineer's relationship with the atom. Other uses for nuclear materials and methods are also important — perhaps even more interesting.

Conventional Processes and Materials

Mixing Control

In processes where mixing of two or more materials is an important and time-consuming operation, many samples have had to be taken periodically from the mixer and additional mixing time allowed as a safety factor. Now, by using minute quantities of radioisotopes in the mix and providing a means for recording the radioactivity on the blades of the mixing paddles, it is possible to determine continuously the degree of mixing and know almost to the second when the proper degree of mixing has been attained. Obviously, the production rate from a given size of mixer will be increased by use of this new technique.

Measurement of Wear Rate

In determining the effectiveness of new materials for a given application, one of the most important items is the susceptibility to wear by friction. By means of radioisotopes it is now possible to measure wear rate much more rapidly than under the old system of simply putting the item into use and waiting until significant changes in appearance or weight occurred. For instance, by irradiating the steel in a piston ring and running it in an engine, the wear experienced by the ring (measured by the pick-up of radioactivity in the oil) can be determined to a degree not formerly possible. Not only can the total wear be measured, but also the rate of wear. This is done by recording the rate of change in radioactivity of the lubricant. This same

principle can be applied to test other materials or to test heat treating practices on materials used for the edges of cutting tools.

Thickness Gages

A material whose thickness is to be measured or controlled is passed between a source of radiation (generally gamma-ray or beta-ray) and a detection instrument.[2] Variations in the thickness or density of the material will cause equivalent variations in the intensity of radiation received by the detector. Figure 1 shows a schematic layout of a beta-ray gage assembly for strip mill use. The use of these gages in strategic locations in strip mills makes it possible to have continuous recording of the thickness of the strip as it is being processed through the mill and also to activate control mechanisms for changing the mill settings during rolling. An additional advantage can be obtained from multiple gages across the width of the strip, giving essentially complete control of strip thickness.

Dense Concretes

The development of atomic energy has necessitated the use of massive shielding for the attenuation of intense radiation. When dealing with the most common type of radiation, gamma rays, the density of the shield gives a rough approximation of its relative effectiveness in stopping the radiation. This, and the requirement of maximum area for experimental work in the vicinity of the radiation source, has encouraged the development of dense concretes. Pound for pound, concrete has generally been the cheapest material for shielding. By using Portland cement with such materials as steel shot, magnetite, or barytes for aggregate (and even as fines), it has been possible to obtain concretes with densities as high as 370 lbs per cu ft. Much of the dense concrete poured to date has been for small installations around research reactors although large scale pours have been made at the Hanford Plutonium Works and other major installations. However, each one of these pours was a special job, and the cost per yard has been extraordinarily high. Such problems as the installation of pipe for placement of grout, the complications brought on by the passage of casing for beam holes through the shield, and the labor of prepacking the aggregate present a challenge to engineers in developing low-cost means for placing such dense concretes. Table I shows typical concrete mixes for obtaining high densities.

Probably the most important type of shielding for the future will be that required for mobile reactors. The use of conventional massive shields for either nuclear-powered aircraft or locomotives adds tremendous weight to the vehicle. Engineers are currently working on the use of materials other than concrete for making "light-weight" shields. Although the materials to be used will be much more expensive than concrete, their lightness, particularly in aircraft, will make them worth while.

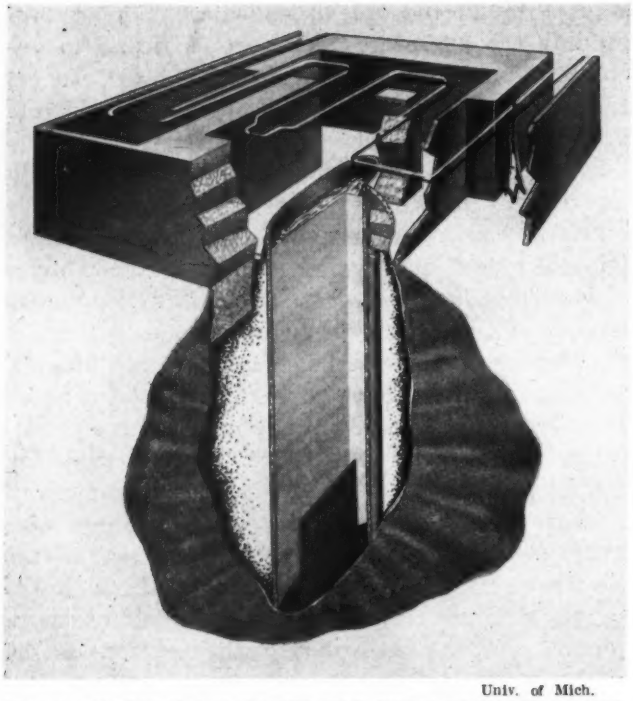
Most shielding is designed for the attenuation of gamma rays. A substantial portion of these rays result from neutron absorption in that part of the concrete shield nearest the reactor. Although the neutrons do not travel through the shield as far as gamma rays, the absorption of the neutrons in the shield results in relatively powerful gamma rays being generated within the shield itself. Thus, if there were a means for absorbing the neutrons in the part of the shield nearest the reactor and the absorbing material in turn did not emit gamma rays, then an appreciable portion of the total gamma rays emitted by conventional concrete shields would be eliminated. Most of the work involved in these "light-weight" shields is classified but it is reasonable to assume that considerable progress is being made in their development along these lines.

Flue Dust From a Blast Furnace

A new technique has been developed for evaluating comparative amounts of flue dust from different types of ore fed into a blast furnace. The steel industry has always assumed that it is necessary to agglomerate fine material in order for it to travel with the burden of a blast furnace until the material reached the smelting zone. The Ford Motor Company has conducted tests to determine the feasibility of charging iron ore fines into the blast furnace without experiencing excessive flue dust losses. The Ford experiment involved making a portion of the fines radioactive and then checking the radioactivity

TABLE 1 — MATERIALS LIST FOR TYPICAL HIGH-DENSITY CONCRETES

	Concrete Density	Materials — Lbs/Yd³				
	Lbs/Ft³	Cement	Sand	Aggregate	Steel Scrap	Water
1. Magnetite sand & agg. (275 lbs/ft³)	312	671	720	4230	1540	268
2. Hematite sand & agg. (258 lbs/ft³)	318	671	720	5330	—	268
3. Limonite sand & agg. (230 lbs/ft³)	237	626	670	3300	1380	250
4. Barytes sand & agg. (275 lbs/ft³)	275	650	696	3000	2840	259
5. Barytes sand & agg. (230 lbs/ft³)	275	650	696	4610	—	259



Univ. of Mich.

FIG. 2—RADIATION CHAMBER FOR PORK PACKING PLANT.

in the dust collection system, the pig iron, and the slag. The further development of this use of radioisotopes could lead to important changes in blast furnace design and charging practices and the beneficiation of various types of ores. For instance, it might be possible to charge certain ore fines without excessive dust loss if they are charged concurrently with larger material. Until this technique of using radioactive particles was developed, it was impossible to determine quantitatively the relative dust loss of different ores charged in that way.

Current Developments Lead To New Business

There are other developments that should be of equal interest to indusrty but need the help of engineers in attaining commercial status.

Food Sterilization

One development close to commercial application is food pasteurization and sterilization by means of irradiation. It appears certain that when laboratories at M.I.T. and University of Michigan have completed their current projects on dosages and energy levels of irradiation, facilities will be installed within existing plants. Forward-looking food engineers would specify irradiation facilities for new processing plants.

Sterilization may be applied to meat, vegetables, and milk. Layouts have already been prepared by those working on this project at the University of Michigan for the integration of a sterilization plant within a conventional pork-packing plant. The major health problem with pork is the closed cycle infestation of trichina resulting from the extensive feeding of garbage to hogs, since the garbage contains waste pork products from which the infection has not been removed.[3] By enforced irradiation of pork products at the packing plants, the cycle can be broken. Figure 2 shows one design by the University of Michigan researchers for a radiation facility layout for a pork-packing plant. Competent medical authorities estimate that 25,000,000 people in the United States are infected with trichina in varying degrees. As a result of radiation sterilization, it is conceivable that trichinosis in the United States some day soon may be of historic interest only.

Another effect of sterilization by nuclear radiation is increased shelf-life of foods. One example is raw meat which has shown as much as 20 times extended storage life after only low-level dosages sufficient to effect pasteurization. Another example is the inhibiting of potato sprouting for at least 18 months; the radiation kills the enzymes. In essentially all the work pertaining to the irradiation of foods, the principal problem is in balancing the radiation dose necessary against the detrimental affect on the flavor of the food.

Heavy Water

Nuclear reactor concepts for the production of electrical power may be placed in two general categories: those reactors that can operate with natural uranium fuel, and those requiring isotopically enriched fissionable fuels. Unless the nuclear power industry can economically breed more fissionable fuel than it consumes, and this is problematical, the use of enriched fissionable fuels imposes a dependency on critical Government fissionable material production plants. On the other hand, power reactors using heavy water for neutron moderation can employ natural uranium as fuel.

Now, if we assume (1) that the population will increase at somewhat less than the current rate, and that the per capita energy will increase at the same rate as for the period 1930-50; (2) that by 1980 thirty per cent of the new power plants being constructed will use nuclear energy; and (3) that about fifty per cent of these plants employ heavy water; then the requirements for this material at that time would be more than 1,000 tons per year. This might represent a capital investment of approximately $300,000,000 and an annual business of $80,000,000.

Heavy water production might be undertaken in either of two ways: as a completely integrated production plant using one or a combination of processes; or as a by-product operation to an existing industry such as ammonia synthesis.[4] This method is a parasitic operation, and its heavy water productivity would be limited to the capacity of the ammonia synthesis plant. While the independent heavy water plant would not be limited capacity-wise, its capital and operating costs might be higher

depending upon the circumstances and the processes employed.

Research Reactors

Research reactors are used for the training of scientists and engineers; the testing of materials under radiation; the development of new concepts in nuclear physics, shielding, and chemistry; and the production of radioisotopes. As the commercial use of radiation expands, the need for radiation research facilities will increase even more. In many instances the simple gamma radiation from radioisotopes is not sufficient to obtain the test data needed either from the standpoint of the time element or the internal changes on the specimen under test. The nuclear reactor itself must then be used in order to obtain the necessary intensity of gamma and neutron radiation.

The radiation from reactors has significant effects on the properties of materials, and the changes cannot be predicted. The engineer must test and then evaluate these effects before he can incorporate the proposed materials in reactor designs. Thus, the need for materials testing reactors has expanded faster than the available radiation time in the existing units.

Much has been written about the use of radioisotopes in medicine, industry, and agriculture. The production of these radioisotopes has become a fair sized business. However, in view of the fact that essentially all of the radioisotopes have been produced in reactors located at only two of the national laboratories and are of necessity, somewhat distant from the average point of use, the use of radioisotopes with short half-lives has been retarded. Many of the most useful radioisotopes have very short half-lives, and if they could be produced in research reactors close to the point of commercial use, this would aid immeasurably in developing new uses for radioisotopes.

At present there is only one research reactor operating outside of the national laboratories. However, there are three others under actual construction and approximately five others in various stages of design with a definite program for construction. Additionally, there are at least twenty other reactors being considered for either university or industrial use. Although the primary purpose of most of these contemplated reactors is not the production of radioisotopes, they could certainly be used for the production of short-lived isotopes when needed.

Today there are several types of reactors used for research. However, there is still much engineering to be done in fitting the design of future reactors to the needs of science and industry. As an example, new principles in reactor design must be developed in order to accommodate the testing of very large specimens within the reactor core; this has not been done to date. The three principal types of research reactors now being considered by most potential owners are the pool type, the water boiler, and the tank type (either light- or heavy-water moderated). Although at least one of each of these types is in operation, there are still many refinements to be made, and on each proposal the engineer is required to use his ingenuity.

Figure 3 shows an artist's perspective of a pool-type reactor and appurtenant facilities. As with the Army Package Power Reactor, there is still an element of development and contingency in the design and construction of even a research reactor. The recent fixed-price bids for a research reactor in the Middle West were spread by a factor of more than two-to-one between the low and high bids. Thus, one may conclude that there is still plenty of engineering to be done in this specialized field. There certainly has been no standardization yet, although the fabricators are striving mightily.

Low Temperature Processes

The low temperature distillation of sea water to fresh water by means of a reactor with low power density is an interesting development. Another use for a reactor of this kind would be for space heating of homes and industrial buildings. This type of reactor could utilize partially spent fuels from power reactors requiring high power density in the core. In these two instances, many of the troublesome engineering problems attendant upon the use of high-pressure water and steam in the projected nuclear power plants would be absent. It should be obvious what developments of this nature could do for world's standard of living as soon as they are commercially feasible.

Heat-Sensitive Drugs

Some drugs, such as penicillin, are especially sensitive to the temperatures required for sterilization; inspection shows that large quantities of some

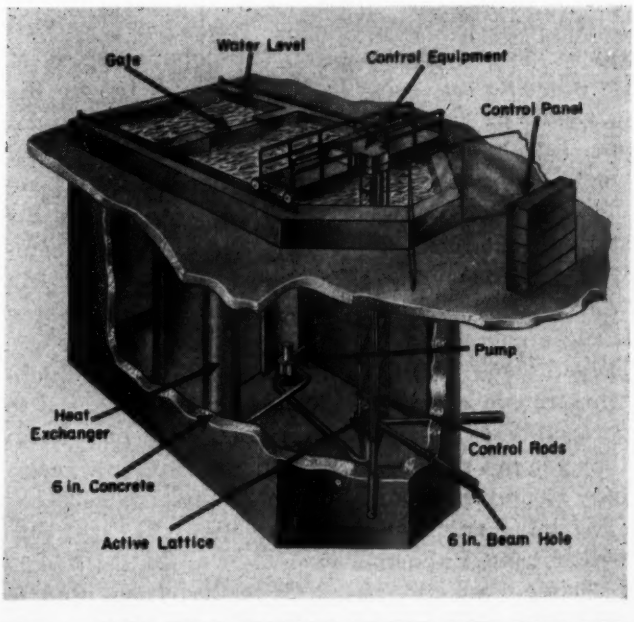


FIG. 3—POOL TYPE REACTOR OF THE TYPE USED FOR RESEARCH FOR INDUSTRY, MEDICINE, AND AGRICULTURE.

drugs must be discarded for lack of sterility after conventional treatment. It has been demonstrated that gamma radiation will effectively sterilize the drugs without modifying the chemical structure. A further advantage is that the drugs can be packaged and then passed through the irradiation facility; thus, any chance for recontamination after irradiation is obviated.

Spent Fuel Recovery and Waste Disposal

It is known that many research institutions under AEC contract have been attempting to find satisfactory and economical means for the chemical processing of spent fuels and the disposition of radioactive waste products generated by nuclear reactors. Most industrial firms studying the commercial aspects of nuclear power have neglected the problem, reasoning, possibly, that waste disposal is up to the Atomic Energy Commission. Undoubtedly, the urgency of solving the power reactor design and operating problems has resulted in neglect of the development of economic by-product recovery and waste disposal. Nevertheless, they are worth investigating because it is just possible that the by-product credits may make nuclear power competitive a great deal sooner that otherwise. Furthermore, the cost of waste disposal by means now employed, i.e., steel underground tanks or dumping in the ocean, is exceedingly high. Others have calculated that ocean dumping could not continue for very long once the wastes to be disposed of have reached significant quantities. When there are many nuclear power plants in operation, the radiation damage to marine life would be excessive.

Among many informed engineers, it is the consensus that the future of the nuclear power industry is dependent upon the successful development of economic waste disposal processes.

Polymerization of Organic Chemicals

Research and development work being carried out at many laboratories on the polymerization of organic chemicals by irradiation may be on the threshold of yielding results leading to commercial use. Surely, one can take a sanguine point of view when reading of Standard Oil Company of New Jersey's plans for a million-dollar laboratory for studying the effect of Co-60 radiation on the chemistry of oil refining. A progressive engineering firm would wish to be in the position of translating these nuclear energy innovations to practical application. Polyethylene plastic is made at present in high-temperature retorts that are expensive and hard to control. Preliminary development work has shown that gamma rays promote polymerization, a necessary step in the formation of polyethylene. This calls for further engineering investigation.

Vulcanizing Rubber

Gamma radiation from Co-60 has been used to vulcanize both natural and synthetic rubber. This process eliminates heat and chemical agents both of which are now required in the conventional process. Many of the details must still be worked out and long-range wear tests performed in order to insure the stability of the product. However, it is hoped that vulcanization by radiation will increase production rates significantly.

Chemical Transformations

Recent experiments in one of the university laboratories have shown the possibility of transforming CO_2 into CO by intense irradiation. Since CO is a very important building block in the formation of organic chemicals, its formation as a cheap by-product of reactor operation would be quite profitable. It is possible that additional research will bring this phenomenon to the brink of commercial feasibility. Then the engineers will be called upon to take the process from the laboratories into pilot plant and commercial operation. If it is possible to convert CO_2 to CO, then why can we not dream of reducing alumina to aluminum directly by the same method? It is unnecessary to dwell on what this would mean in cost saving, as electric energy constitutes approximately 20 percent of the current cost of transforming alumina to aluminum.

There are other radiation-catalyzed reactions the investigation of which has proceeded to an even greater degree. These include the production of ethylene glycol from methanol, phenol from benzene and water, hydrazine from ammonia, and the synthesis of ammonia at lower temperatures and pressures than in the Haber process.

Specific Problems for the Engineer

This discussion has dealt with the various processes and products utilizing the principles of nuclear energy in which the work of the professional engineer is needed for further development and industrial application. However, it would be of further interest to describe briefly some of the specific problems with which the various engineering disciplines are wrestling today.

Chemical Engineers

A large portion of the applications of nuclear energy being investigated involve chemical processing techniques. Therefore, it is not surprising that the chemical engineer has had and will continue to have a predominant part in the development, design, and operation of nuclear facilities. For example, chemical processing plants for the recovery and refinement of fissionable and fertile materials from irradiated fuels and the handling of fission product wastes at low operating and maintenance costs are a real challenge to chemical engineers.

One of the principal problems in the design of chemical processing plants, reactors, and appurtenant equipment is corrosion. Most of the products of corrosion become highly radioactive and require elaborate biological safeguards. This situation is aggravated when maintenance is necessary, as the

equipment through which the coolants flow will retain its radioactivity unless flushed completely, or long periods of time are allowed for radioactive decay to take effect. This same problem of induced radioactivity in the coolant requires elaborate water treatment facilities to remove impurities whenever water is used as the coolant. Where a liquid metal such as sodium is used as a coolant, the purity of the liquid metal is a major consideration; only a few parts per million of oxygen in the sodium will result in rapid corrosion of the containing medium.

Mechanical Engineers

No matter what success the mechanical engineer has had in the development of effective heat transfer methods, the challenge of cooling nuclear reactors will test the most ingenious. The power density of reactors being designed today is as much as twenty times that of even the most powerful Naval boilers and is almost comparable with that prevailing in gas turbines. Accordingly, the higher heat fluxes encountered have caused higher temperature gradients in relatively small structures; these, in turn, have caused high thermal stresses. Furthermore, the engineer's choice of materials for coolants is very limited; he must find one that will not "poison" the reactor inordinately, will not become excessively radioactive, and at the same time will not corrode fuel elements, pumps, and piping.

The mechanical engineer has also been faced with the development of completely leak-proof valves and pumps, maintenance by remote control, and the development of fool-proof safety rod mechanisms. With such dangerous materials as sodium or a very expensive material such as heavy water, it is imperative that there be no leaks. In addition, many pieces of intricate equipment must be constructed to go into spaces restricted in size by nuclear considerations. With safety rods that must fall or be driven into long slots with very little tolerance, the mechanical engineer must design for utmost precision in every aspect.

Metallurgical Engineers

It is difficult to define the line between the metallurgist in research and the metallurgical engineer in industrial practice. However, the phenomena of extremely high temperatures and dense radiation on reactor materials have required considerable reorientation in the metallurgical engineer's thinking with respect to the use of conventional materials. Fortunately, in one respect, reactor technology has fostered the development of new materials such as zirconium, tantalum, molybdenum, and cermets. Unfortunately in another respect, it has multiplied the alternatives for application of these materials and has made the metallurgist's job more difficult in keeping abreast of the latest developments and in specifying the material to be used. As one cannot predict the radiation damage to be experienced by materials under various radiation fluxes, radiation energies, and temperatures, the resulting requirement of actual testing in a reactor has placed a tremendous burden upon the few materials-testing reactors available. Furthermore, these reactors have definite limitations as to their ability to simulate the conditions to be experienced by coolants and structural materials which are foreseen in future reactors now being designed.

Electrical and Electronics Engineers

While the electrical and electronics engineers have so far been able to maintain an amazing record of safety for the operation of reactors in this country, their search continues for simplified designs for the various circuits required and for more compact instrumentation. It is to the credit of this group that they have been able to design and build virtually any control system required to operate reactors and appurtenant facilities—mostly without fancy research budgets and expensive test units.

Civil Engineers

Civil engineers face problems in improved design of dense concrete shields and particularly of more economical methods for placing the concrete. In the chemical separation plants, such as at Hanford and Savannah River, essentially all maintenance work is carried out by remote control; this means the floors and wells and piping have to be laid out to extremely close tolerances in order to accommodate prefabricated equipment changes. In plants such as these, material is not bent or welded to fit—it must be screwed in place by remote operation observed by periscope or television picture.

Another problem for the civil engineer is in the design of underground structures. Many of the nuclear power plants are being designed for containment in steel pressure vessels, which may be partly or wholly below ground level. In addition, heat exchanger and turbine galleries may be located in simulated rock caves. All these design features are for increased containment in the event of a nuclear incident, but they certainly add to the problems of the civil engineer.

Responsibility of the Profession

The developments described and the specific problems involved give just a hint of the future for consulting engineers. They point to the responsibility of a progressive engineering firm to acquire the knowledge and experience needed to serve clients in the coming era of the atom. ▲▲

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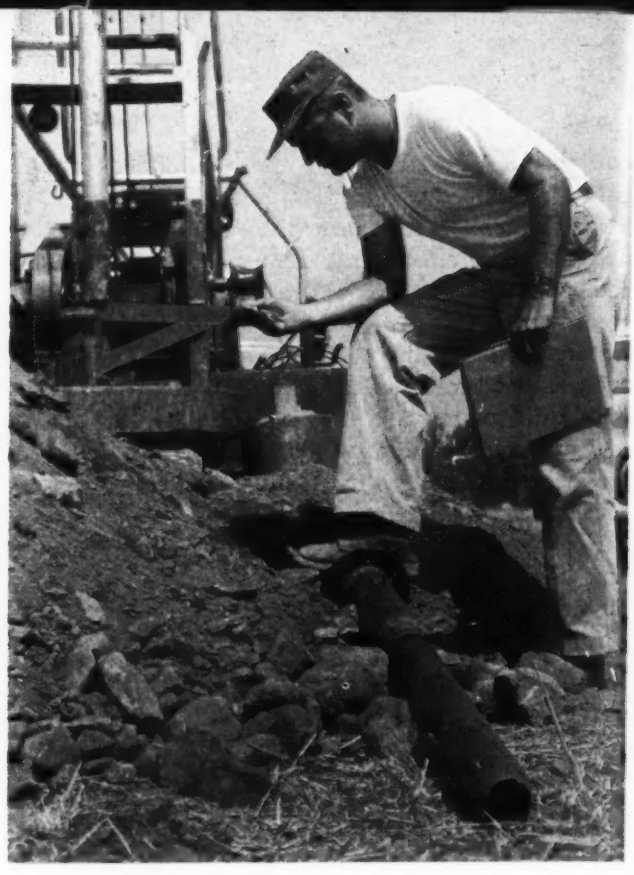


CLOSE SUPERVISION OF EXPLORATION AND SAMPLING BY ENGINEERS VERSED IN ALL PHASES OF SOIL MECHANICS IS NECESSARY TO OBTAIN ACCURATE SITE INFORMATION.

Soil Mechanics Is a Science . . .

JAMES T. CARTER, Partner, Dames & Moore

James T. Carter, a native Texan, received B.S. and M.S.C.E. degrees from the University of Texas. After brief experience in sanitary and canal engineering, he started as an engineer analyst with Dames & Moore in 1948. Since then, he has worked on field, laboratory, and office phases of soil mechanics engineering in this country, Australia, and the Philippines. Mr. Carter became a partner in the firm of Dames & Moore in February, 1954. The conclusions expressed in this article were derived from an exacting evaluation of completed foundation investigations to see what methods produced the best results.

INDUSTRIAL GROWTH in recent years, together with increasingly complex economics, has forced the use of formerly rejected building sites. This trend toward marginal property utilization, plus the development of heavier, more complicated industrial process equipment, has broadened and aided in maturing the soil mechanics branch of civil engineering. Yet soil mechanics engineers often hear such comments as, "Since you people are dealing with construction materials of variable properties and of unknown extent, your engineering must be either witchcraft or a guessing game."

Perhaps this viewpoint has some basis because there have been some extremely poor solutions to foundation and soils problems. Lack of enough information or too much information unrelated to the problem at hand do make some soil mechanics investigations expensive guessing games. However, when the nature of soil as a construction material is recognized and understood, and this knowledge is applied properly, soil reactions under proposed construction conditions can be predicted accurately. The accepted procedure is to explore the site and collect significant data, rationally relate these data to the project design, and pick the best method that will fully, safely, and economically satisfy the functions required of the proposed construction.

Soil mechanics studies are organized in much the same manner as any other engineering investigation. The first step is to get some idea of the extent of the soil components as they exist. This exploration phase generally is accomplished by means of a geologic

survey, physical reconnaissance, probings, exploration borings, open pits, exploration geophysics, or a combination of several of these tools. Next the physical characteristics and the extent of each material is determined to a degree of precision commensurate with the problem, and these data are examined in the light of all feasible construction plans. Then different methods are compared, particularly on an economic basis, and a "best solution" is selected. Finally, detailed design of the project is completed.

Exploration

Two important conditions influence exploratory work. Soil distribution is variable, and soil properties, even in similar deposits, are not constant. These characteristics, combined with the uncertainties inherent in the various drilling and sampling procedures, prevent standardized rules for exploration or results interpretation. Both the test methods and subsequent analyses are governed by the actual site conditions encountered and by the requirements of the proposed construction.

In practice, the field work should be directed continuously by an engineer who is not only well versed in all phases of soil mechanics but who can visualize the operational demands of the development. He must become intimately familiar with the site and must recognize the importance of its characteristics with respect to the proposed construction. He must understand exploration processes completely so he can obtain all data that will be pertinent to the designer and must organize these data in usable form.

Oil Refinery Project

One recent examination of an oil refinery site illustrates the importance of the exploration on the final outcome of an industrial development. This job site was remote from well established investigational facilities. For this and several other reasons the exploratory work was undertaken as a separate and distinct job from the testing and engineering analyses. The preliminary site investigations were made by wash-boring. With this method, a jet of water is directed through a small diameter wash pipe into the soil. The jetting action loosens the soil and washes it up the outside of the wash pipe where it is spilled into a sump or wasted.

At this particular project, the preliminary wash borings seemed to encounter moderately firm clay and gravel throughout the entire depths explored. Samples were collected by catching fragments of the washed soil in a strainer held under the flow of water coming from the boring. These samples were shipped to a laboratory for examination, and apparently there were no significant area variations in the underground conditions. It appeared that the foundation soils would not influence the layout.

Later, more detailed explorations were made with a trained field engineer directing the operations. He soon discovered that while the upper soils contained an appreciable amount of gravel, extremely soft clay and peat underlaid the surface soils over a part of the site. It became obvious that there was no particularly advantageous location for process units, and that tankage would require piling or other fairly expensive foundations at all but one area on the site. Recognizing what the presence and distribution of soft soils would mean to the designer, the field engineer quickly relayed the information to the office. The refinery layout was rearranged to satisfy the actual conditions with very little lost time.

Considering the reason for the original misconception, it is believed that as the preliminary washings dislodged the gravel near the surface, only part of the gravel particles were carried out by the exhaust flow. The remainder in the bottom of the hole advanced with the boring, and probably some particles subsequently were washed out at each depth. Thus, the preliminary samples were not truly representative of the subsurface soils. During the detailed exploration, the trained engineer obtained undisturbed samples by making certain the borings were washed clean at each depth — and this accurately revealed the true underground conditions at the site.

Organizing Soil Mechanics Investigations

The nonhomogeneous nature of soil and the effect of test methods on the ultimate results are important factors to consider when organizing physical exploratory work. Naturally, more mundane matters, such as time and available funds, also must be resolved to reduce soil testing from an academic statistical problem to a practical investigation of critical soil properties. The best arrangements can be made when the field engineer who is familiar with the site and the engineer who will use the test results pool their knowledge. With each knowing the others tools and objective, a realistic program can be developed to simulate field conditions and loadings in the laboratory.

Field tests have value, but generally they are quite limited in the extent to which the results may be applied. Laboratory testing permits investigation of soils at more areas within the site and under a wider range of loading conditions. The development of an adequate testing program can best be done by engineers who can visualize the various directions the solution of the problem may take. A great variety of tests are available, and since each has its own limitations, precaution in interpretation is imperative. When there are unusual or even unique conditions to consider, new tests may be devised.

Settlement Problem

Selection of test methods can be illustrated by a recent investigation involving a problem of supporting a new turbine generator on the existing foundation of an older, smaller unit. The older turbine gen-

JOB ENGINEER EXAMINES SOIL SAMPLE FROM BORING DURING THE EXPLORATORY WORK ON A PROJECT SITE.

erator had experienced some settlement, and the possibility of large movements of the new unit was of concern to the designers. Usually, settlement predictions are derived from consolidation or compression test data. In these tests, samples of the soils to be influenced by the construction are subjected to static loads imposing pressures up to and beyond those anticipated in the field. However, at this project, while samples of sand underlying the foundation were tested in compression,, a quantitative determination of future movements would have been very difficult.

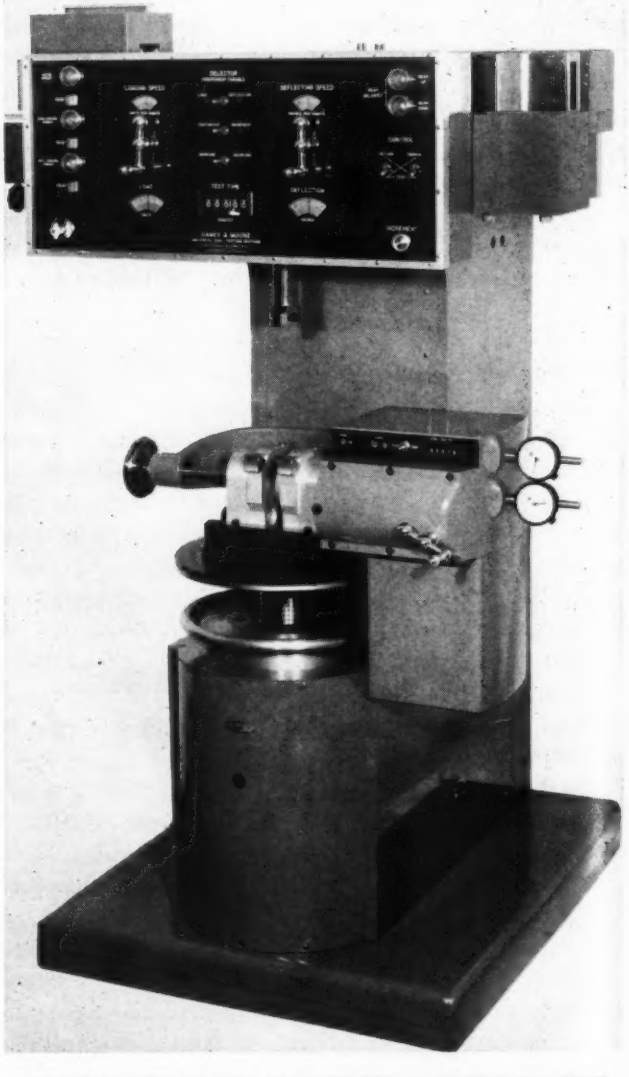
Cooperative study of the problem indicated a qualitative evaluation of the vibratory effects would be sufficient to permit an adequate design. Sand samples were subjected to vibrations of the same frequency as the new turbine generator. Successive cycles of vibrations were applied to the sample at several compression loadings corresponding to the unit loadings of the new unit. These tests showed that repeated cycles of vibration did not cause large strains after the first moderately large strains had occurred. It was concluded that the new unit would not settle significantly if it imposed forces dynamically similar to the older unit on the foundation soils, and if the uniformity of the soil immediately underlying the foundation were assured by pressure grouting.

Communication

Although mathematical analysis of site data probably receives more attention than any other phase of soil mechanics, the analysis is only as good as the data upon which it is based. This is the basic reason for having the explorations closely supervised and tailoring the testing to the problem at hand. Good communication then becomes a prime requisite to obtaining effective results. The exploration engineer and the analyst must talk the same language. The tailor-made laboratory tests actually must be what the analyst ordered, and the results must be in a form that is understandable and usable to the analyst.

Relationship With Client

A still more important channel of communication is that between the specialist who analyzes the soil reaction and the men he serves—structural designers, chemical engineers, and mechanical engineers. The analyst must know the other specialists' problems and reach a common understanding with them. He must be able to obtain and to evaluate the requirements of all machinery and equipment as well as the building structure itself. Soil mechanics work can provide maximum economies only when all as-



LOADING DEVICE FOR SOIL TESTS. A GREAT VARIETY OF TESTS MAY BE MADE, BUT EACH TEST SHOULD BE TAILOR-MADE TO THE PROBLEM BEING INVESTIGATED.

pects of the functions of a complete project and all possible solutions receive detailed consideration.

After a range of acceptable solutions is known, several of them should be compared in detail. At this point in the study, experience, good judgment, and careful mathematical analyses are equally valuable. When the final design is selected, it also is worth while to check the clarity of understanding. All decisions that have been reached between the design engineers, together with the significant data developed in the investigation, should be collected and recorded. The designer should have an opportunity to review this material and to be certain that it is in accord with his views. Similarly, the soils engineer should examine the designers' records, the plans, and the specifications.

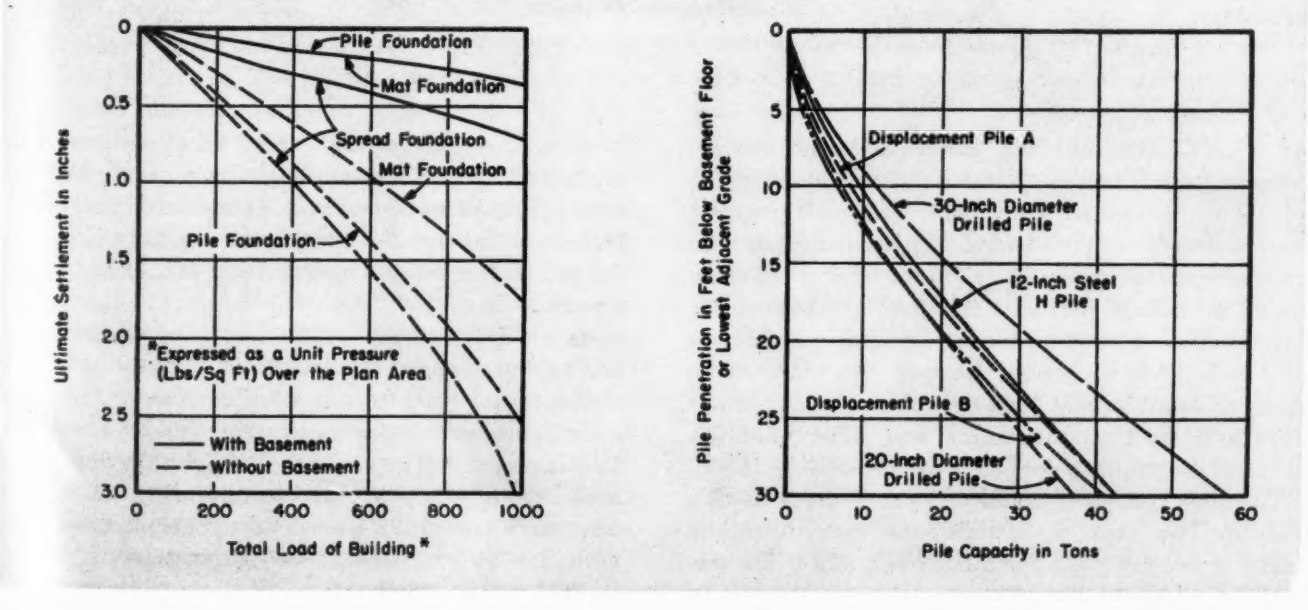
Brewery Case History

Engineering planning and construction at a brewery now in operation on the West Coast, serve as an example of the value of easy exchange of information and of consideration of all possible foundation solutions. On this project, the site was in a broad valley of recent alluvium known to be a heterogeneous, lenticular deposit of moderately soft clays, silts, and some sands. The brewery structure contained vessels and process units extremely sensitive to differential settlement, so the problem seemed to be one of spreading the loadings to deeper and firmer soils by means of piling. The quantitative solution needed was a determination of just how deep to go.

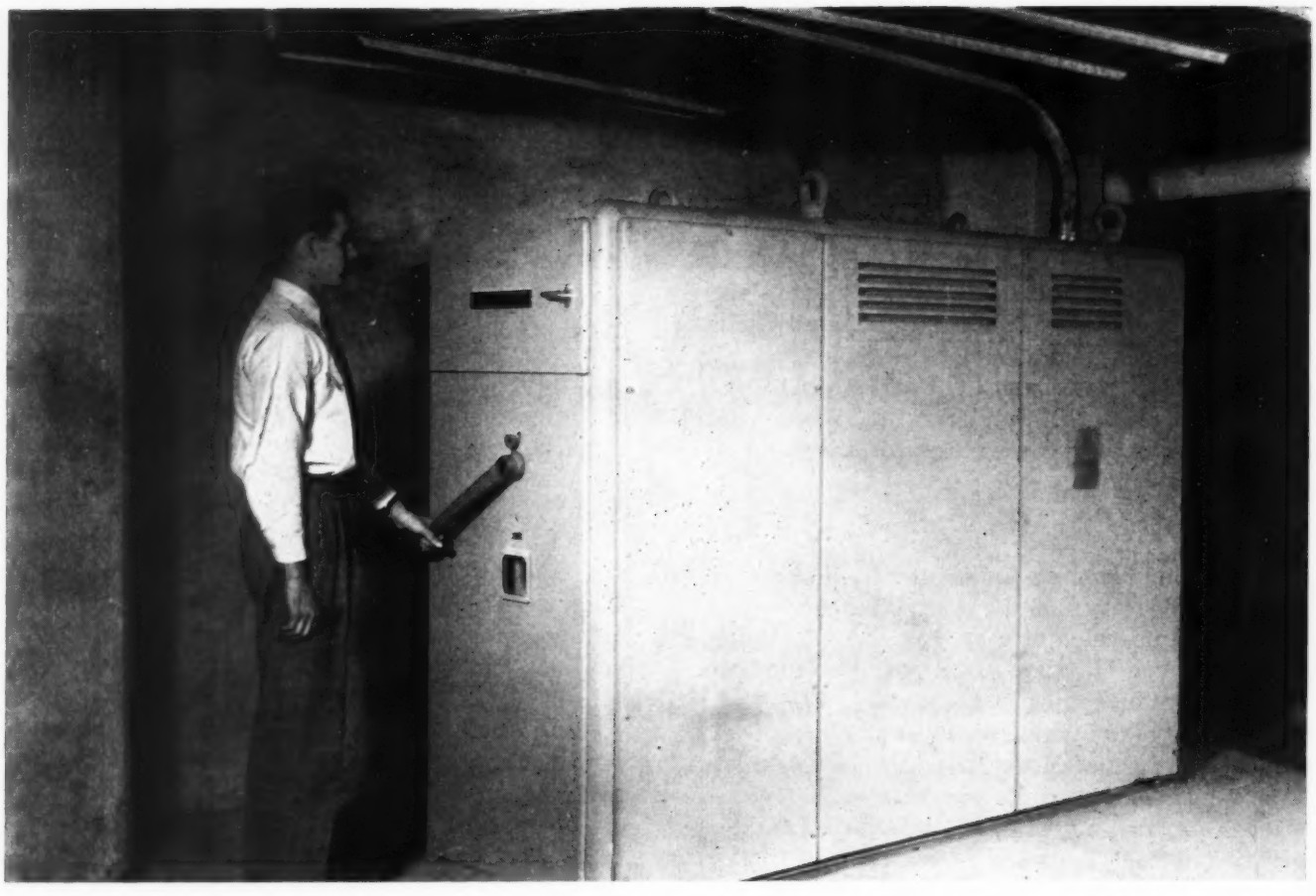
Initially, the site was explored by widely spaced borings on a geometrical pattern. Two or three of the borings encountered a thick stratum of sand at a reasonable depth. The area in which these borings were drilled was investigated, and the thick contiguous stratum of sand was found to be large enough in plan to include most of the heavy and sensitive process units. Then by working closely with the designers, it was determined that column movements would be within tolerable limits if spread footings were founded in this sand. Further, during construction, excavations could be made with rotary, bucket-type drilling equipment.

From these data, design and construction of the foundations were simplified, and considerable savings resulted over the cost of driven pile foundations. Both designers and constructors contributed to these savings through combined knowledge and cooperation. The men conducting the field exploration were alerted to recognize the possibilities of underground conditions affecting the client's problems. The analysts had an open mind about solving the foundation design and were not content merely to determine pile lengths. Perhaps most important of all, the structural designers were anxious to consider various solutions and to discuss the influence of foundation movements on the proposed constructions.

Since all of these examples are based on large developments, the methods, organization, and the importance of exchange of information may seem exaggerated or disproportionate for smaller projects. Obviously, some of these phases can be dismissed on smaller jobs. But to be fully effective, all soil mechanics studies should be developed for the specific problem being investigated and to an extent commensurate with the size of the work. With this approach, tangible, worth-while economies may be realized both in construction costs of the project and in maintenance of the completed installation. ▲▲



GRAPH AT LEFT COMPARING EXPECTED CENTER SETTLEMENTS FOR VARIOUS FOUNDATIONS AND GRAPH AT RIGHT COMPARING CAPACITIES FOR DIFFERENT TYPES OF PILING ARE TYPICAL OF SOIL MECHANICS INVESTIGATONS. SUCH COMPARISONS OF VARIOUS POSSIBLE FOUNDATION SOLUTIONS PROVIDE THE GREATEST PROJECT ECONOMY.



NOISE LEVEL MAY BE IMPORTANT FACTOR IN THIS INSTALLATION IN THE BASEMENT OF A COMMERCIAL BUILDING.

Noise Levels of Indoor Transformers

T. R. SPECHT
Transformer Division
Westinghouse Electric Corporation

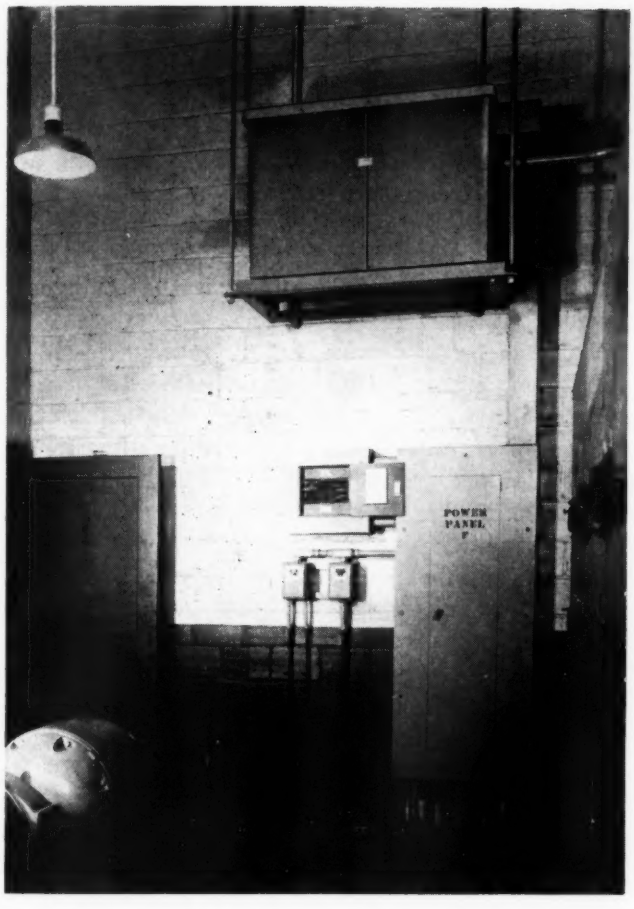
Cp exclusive

WE ALL KNOW that fans, pumps, and other motor-driven apparatus can be sources of noise. They must be located so they will not be nuisances. By comparison, transformers are relatively quiet and are often placed in indoor locations. However, transformers do give off noise, and on indoor installations this can be a real problem unless proper consideration is given to sound level. Typical problem locations are schools, hospitals, auditoriums, and office buildings. In these the sound level has to be reasonably low.

The ideal condition would be to have the sound inaudible. The cost of installations for controlling sound is usually quite high, however, and if the ambient level is low it may be impractical or unnecessary to reduce the transformer sound to inaudibility.

The audibility of a sound is affected by: (1) its frequency, (2) the ambient sound level, (3) the distance between the observer and the sound source, and (4) the nature of the surroundings. In general, a sound level below about 25 decibels is considered inaudible. But since the ambient level has a masking effect on the sound, the actual lower limit of audibility is considerably higher.

As an approximate guide for usual transformer and background noise calculations, if the sound level of the transformer is ten decibels lower than the background sound, the transformer will be inaudible. The background noise is the sound that would be measured at the point of interest with the transformer de-energized. These values are as measured with the "A" or "db 40" weighting network of the sound level meter. For example, if installed in an office having an ambient sound level of 40 db, the transformer's sound level as detected at the nearest work location would have to be 30 db or less to be inaudi-



THIS DRY TYPE TRANSFORMER IS MOUNTED INDOORS BY SUSPENDING IT FROM THE CEILING OF THE ROOM.

ble. If at the transformer location its sound level is 66 db, this means that in some way the sound must be reduced by 36 db between the transformer and the work location. This is a relatively large attenuation and would mean that the transformer should be enclosed by well-sealed walls.

Dry type transformers are used most frequently inside of buildings. The NEMA sound levels for dry-type transformers are given on page 53. The table shows the level of transformers 300 kva and smaller as 66 decibels. Actually, the sound level of the transformers decreases as the size decreases, becoming virtually inaudible for small transformers such as door-bell units. For transformers much smaller than 300 kva it may be desirable to contact the manufacturer during the planning stage to determine what actual transformer sound level can be expected.

If the transformer were placed in an ideal room with walls that were perfectly sound absorbing, there would be no reflected sound energy in the room. Under this condition the sound level at the transformer would be the same as if the transformer were located out of doors, away from any reflecting surfaces. This is essentially the sound level the manufacturer would report for a transformer measured according to the NEMA Standards.

It is not possible to reduce the sound level of a transformer in a room below this figure by the use of sound absorption material in the room. In a room with walls of low absorption the sound from the transformer will reflect back and forth between the walls, resulting in a "build-up" of the sound level in the room. The number of decibels the sound level is increased right at the transformer is approximately:

$$\text{db build-up} = 10 \log_{10} \left(1 + \frac{4\ (1 - a)\ A_T}{a\ A_R}\right)$$

where:

A_T = the surface area of the transformer

A_R = the inside surface area of the room in the same units

a = the average absorption coefficient of the inside surface area of the room

If the walls absorb sound well, the absorption coefficient approaches one, and the build-up is zero. If the area of the room, A_R, is large, again the build-up is zero. The a for the room is calculated as follows if various materials are used on different surfaces of the room:

$$a = \frac{a_1 A_1 + a_2 A_2 + \ldots\ldots}{A_R}$$

where a_1 and A_1 are the absorption coefficient and area, respectively, of a particular surface of the room.

Most of the sound from transformers supplied from a 60-cycle current is at 120 cycles. For the very smallest transformers this may not always be true, but it will be conservative to assume it is 120 cycles. The values of the absorption coefficients used should be at 120 cycles (or 128 cycles as most tables give) instead of the noise reduction coefficient, which is the average of the absorption coefficients at 256, 512, 1024, and 2048 cycles. Usually, the absorption at 128 cycles is low compared to higher frequencies.

Transformers are quite often put in rooms with walls made of poor sound absorbing materials. For instance, poured concrete has an absorption coefficient of 0.01 at 120 cycles per second, and in a room where the ratio $A_R/A_T = 4$, the build-up is 20 db (Figure 1). This means the transformer that measured 66 db outdoors would measure 86 db in this room. Usually build-up of the transformer sound in this room will not be objectionable if the sound can be confined to the room. The attenuation of the sound as it goes through the wall may be so great that the the 20 db build-up of the sound in the room can be tolerated. If it is desirable to control the sound level within the room, it would be necessary to line the walls and ceiling of the room with sound absorbing material. With the low, 120 cycle frequency of transformer sound, the usual materials will give an average room absorption coefficient of 0.3. This will reduce the build-up from 20 db to 5.5 db for $A_R/A_T = 4$. It is doubtful if reduction below 5 db build-up is justified. The ear would hardly be able to notice the difference, and the cost of better sound absorbing ma-

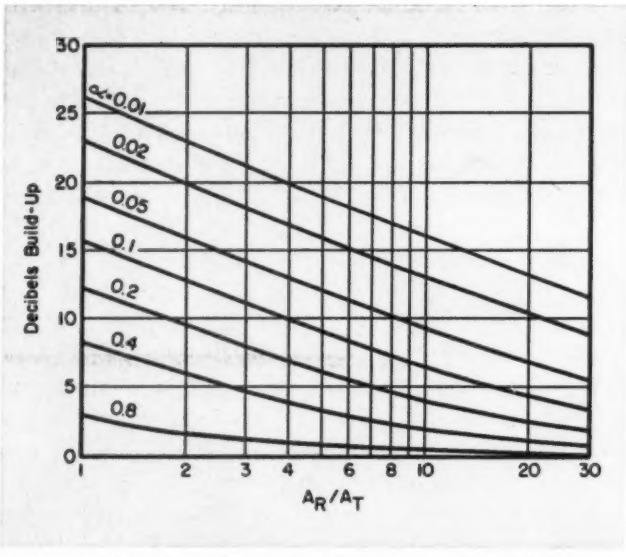


FIG. 1—SOUND LEVEL BUILD-UP FOR INSIDE LOCATIONS.

terials might well be a waste of the client's money.

The equation for the build-up and Figure 1 apply to the sound level at the transformer. At a distance r from the center of the transformer the sound level is approximately:

$$\text{Sound level in db} = SL_0 + 10 \log_{10} \left(\frac{A_T}{4\pi r^2} + \frac{4\ (1-\alpha)\ A_T}{\alpha\ A_R} \right)$$

where:

SL_0 = the average sound level the transformer would have if measured outdoors, or the NEMA sound level

r = the distance from the center of the transformer

To calculate r the transformer is considered to be a sphere of radius r_T such that:

$$4\pi\ r_T^2 = A_T$$

The distance r is then the sum of r_T and the distance from the transformer to the field point. For practical purposes r is the distance from the geometrical center of the transformer to the field point. If the build-up in sound level at the transformer is larger than 3 decibels, the sound level is essentially uniform throughout the room. These equations apply essentially to a transformer towards the center of a room with irregular walls. If this is not the condition, standing waves and focusing will result in some variations from the calculated values at various places about the room.

Transmission of sound out of the room in which the transformer is located can take place through various paths:

¶ Transmission of vibration through the building by direct contact of transformer with floor or wall or through conduit or electrical conductors.

¶ Airborne sound from transformer impinging on walls, the resultant wall vibrations giving rise to the radiation of sound on the other side.

¶ Airborne sound traveling through ducts or other ventilating openings in the room.

In any particular installation any or all of these paths can give trouble. Usually, the transformer rests on the floor. The transformer vibrations can drive the floor, and the resulting vibrations can travel a considerable distance through the structure and then be radiated as sound. It is possible for this to happen even with a basement floor if it is solidly connected to the rest of the building.

This can be controlled by mounting the transformer on vibration dampeners or isolators of various types. With transformers operated only at one frequency, it is not necessary to have damping in the isolator. Hence, purely elastic isolators such as steel springs or rubber are quite satisfactory. Rubber is most frequently used. For good isolation, the natural frequency of vibration of the transformer on the isolators —that is, the weight of the transformer resonating with the elasticity of the isolators — should be small compared to the frequency of the 120 cycle driving force. Usually a natural frequency of 12 cycles — 10 percent of 120 cycles — is adequate.

Where the resonant frequency is a small percentage of the driving frequency, the vibrational force transmitted is approximately proportional to the square of the ratio of the two frequencies, the driving frequency being the denominator. This reduces the vibrational force on the floor to one percent of the value without isolators. If the transformer sound level at a work location is due principally to vibration transmitted through the structure, then the reduction of the vibrational force to one percent will represent a 40 db reduction in sound:

$$20 \log_{10} \left(\frac{1}{.01} \right) = 40.$$

If the transformer's weight is less than the weight of the floor covered by its projected area, the static deflection of the dampener to give this frequency should be approximately 1/16 inch. If the transformer's weight is greater than the weight of the floor covered by its projected area the deflection of the isolator due to the weight of the transformer

APPROXIMATE SOUND LEVELS OF FAMILIAR SOUNDS

Decibels	Sound
120	Nearby thunder
110	Boiler factory
100	Noisy factory
90	Heavy street traffic
80	Average street noise
70	Average factory
60	Department store
50	Quiet residential street
40	Quiet office
30	Quiet home
20	Quiet garden
10	Rustle of leaves

NEMA SOUND LEVELS FOR CLASS AA (Dry Type, Self Cooled) TRANSFORMERS

KVA	Decibels
0 — 300	66
301 — 500	68
501 — 700	70
701 — 1000	72
1001 — 1500	74
1501 — 2000	76
2001 — 3000	78
3001 — 4000	80
4001 — 5000	81

should be determined from the following formula:

$$\text{Deflection (in inches)} = \frac{1/16 \text{ (Transformer Weight)}}{\text{(Weight of Floor Under Transformer)}}$$

It may be practical to put a heavy slab on the floor and put the transformer on isolators on the slab.

The problem of isolating vibration for a wall-mounted transformer is similar to that for a floor-mounted unit.

Conduit attached to the transformer can be driven. Therefore, it is desirable that the conduit be somewhat flexibly attached to the wall near the transformer. Also, if the conduit goes through a wall near the transformer, it is best not to have the conduit cemented into the hole. Where the low voltage leads of a transformer are connected solidly to bus bars, there are possibilities that vibrations can travel along the bars and at some distant point cause a panel to radiate considerable sound. This can be remedied by using a flexible connector between the low voltage leads and the bus bars.

The attenuation of sound through a wall is principally a function of the weight per unit area of the wall. For sounds with frequencies in the range of transformers, the attenuation of a wall weighing ten pounds per square foot is 37 decibels. Each time this weight is doubled, the attenuation increases four decibels Each time it is halved, the attenuation decreases four decibels. However, the wall must be non-porous—that is, air under pressure must not be able to flow through the wall. If porous materials such as cinder blocks are used, they can be made non-porous by putting a coating of plaster on either or both sides. Data is available on attenuation through porous materials. For some porous materials, the attenuation is ⅓ to ½ of that for non-porous materials of the same weight.

It is interesting to note that in general, non-porous, heavyweight materials prevent transmission of sound through a wall while porous, lightweight materials make good absorbing materials.

If a transformer is in a room, it is necessary that the doors be sealed with weather-stripping or an equivalent method. Small cracks let through considerable sound. It may also be desirable where large attenuations are necessary to use double doors to the room. The doors should be separated from each other as much as possible. If the separation is 6 inches, the attenuation will be about 10 to 15 decibels more than it is for one door.

It is usually necessary to provide ventilation for transformers located in a room, unless they are quite small. Excessive sound may come through the openings provided for ventilation. If an air duct is used, it is possible to line the duct with sound-absorbing material. If it is a simple opening, it may be possible to use a short piece of duct and line it with sound absorbing material. The attenuation in db per foot of duct treated with sound absorbent material is: *

$$\text{Attenuation of duct-lining material in db/ft} = \frac{12.6a^{1.4}\,P}{A}$$

where:

a = the absorption coefficient for the duct lining material

P = the perimeter of the duct in inches

A = the cross-sectional area of the duct in sq in.

Assume that a material for this purpose has an absorption coefficient of 0.25 at 120 cps. For high absorption in short lengths, the duct should be split into vertical parallel sections. As a result of doing this, if a duct opening was ¼ inch wide, and the height considerably greater, the ratio of the perimeter of the duct to the area of the duct, P/A, would be approximately 8. [$P/A = (2h + ½) \div (¼ \times h)$. Assuming the ½ in the numerator to be negligible, $P/A = 8$]. The attenuation would be $1.8 \times 8 = 14.4$ db per foot. The sound level at the exit of the duct will be the sound level at the entrance less the duct attenuation. At a distance from the duct exit, the sound level is reduced by the spreading of the sound as it leaves the exit. Reflections from adjacent surfaces will have an effect, but if the duct opening is small compared to the size of the room at the exit end, the sound level at a point located a distance away from the exit grill equal to twice the perimeter of the exit grill will be about 20 db lower than the sound level at the grill.

There is also air noise due to the flow of air out of or into the duct. Methods of calculating this are available, but this air flow noise is much less objectionable than transformer sound and tends to mask the transformer sound.

There are many places where transformers can be located without special precautions. If they are located in areas where there is some natural background sound produced by fans, pumps, motors, or factory work areas, the transformers may be inaudible. Small transformers can even be located in areas that do not have appreciable background noise. Whether audible hum can be tolerated will depend on psychological factors, such as the tolerance of the listeners to the sound, interference with mental concentration, communication, or sleep. ▲▲

*From *Acoustical Designing in Architecture* by V. O. Knudsen and C. M. Harris, John Wiley and Sons, Inc.

PLANNING THE ENGINEERING REPORT

JOHN R. MAYER, Reports Editor
Ebasco Services, Incorporated

CE exclusive

EVERY CONSULTING ENGINEER probably recognizes at an early stage in his career that report writing can be an important — if not always welcome — part of his professional life. He may not, however, recognize so soon that the way a report is written is equally important. He may tend to feel, as some engineers seem to, that as long as the "meat" of the subject is there, extensive fussing over its manner of arrangement or expression is a somewhat unwarranted expenditure of time.

The meat of the subject, however, is often much clearer to the author who carved it than it is to others. The truth is that no matter how valuable a fact, a conclusion, or a recommendation may seem, it is of very little value if its originator cannot communicate it clearly, accurately, and convincingly to others.

Where an engineering report is concerned, this is especially pertinent, for the report is usually a complex blend of facts that have been determined and advice and suggestions based on these facts. The whole is so interwoven or interrelated as to make essential a careful and intelligent plan of organization if there is to be a clear pattern of thought.

Lack of attention to the manner in which a report is prepared is often evident from the defects in the finished product. The report may, for example, contain a large volume of detail not essential to the purposes for which it was prepared. It may be poorly organized, with an illogical or haphazard sequence of thoughts. Clear-cut conclusions may be omitted at points where they are most needed, or conclusions given may not to be logically based on the data provided in the report.

All of these defects spring from lack of planning, improper planning, or failure to adhere to the outline plan as originally drawn; and they sometimes reflect the practice of premature preparation of portions of the report before a clear understanding of the report's purpose has been formed in the author's mind.

Since a client will judge a report by the extent to which it satisfies his requirements, its structure should be based directly on the purposes it is to serve. Hence, the author must adopt the client's point of view in order to be able to plan his report so it will perform the functions for which it will be used.

The first function of any report is to inform the client accurately of the findings and recommendations resulting from the research and analysis for which the consultants have been employed. To accomplish this first function, the report must present all material that is pertinent — and none that is not. Volume alone will not suffice, for while some clients may be impressed by quantity, most will regard it as a needless expenditure of their money.

Another important function of a report is to facilitate the client's understanding of the results of the engineer's study. To accomplish this second function, the report should present the facts in a logical and orderly sequence, at the appropriate depth as suggested by the nature of the problem and the personality and needs of the client. The required clarity of presentation and the proper location of emphasis can be achieved only by careful planning of the report structure before writing begins. The surest way to produce a report that is not clear and does not make a convincing presentation is to begin writing it without a complete and carefully worked out plan.

Some engineers, of course, because of their extensive experience and natural aptitude, can quickly sketch, without great difficulty, the plan of a report. A logical pattern of thought will form in their minds almost from the day they begin work on a project. The larger number of engineers, however, will find it necessary to use a more systematic method. The procedure suggested here is designed as a practical tool to assist these men. Although it may seem elementary, its use will result in a report that is much

better planned and organized than the report written from a hastily drawn outline — or perhaps from no specific outline at all.

In no event should an author attempt to write a report within an arbitrarily selected framework by forcing his material to fit it, nor should he try to adopt the pattern used in some previous report that seems to be similar in nature to his present job. The particular subject matter at hand should be permitted to determine the organizational pattern.

The first essential is the preparation of a concise, one-sentence statement of the basic purpose and limits of the report. This statement will serve to crystallize in the author's mind his objectives, and it should be kept nearby as a testing device while the report planning proceeds. The next step is to review all material gathered for the report and write down on cards or small sheets of paper all the subjects, major and minor, that have revealed themselves in this review. These subjects should then be checked against the statement of purposes and limits to eliminate subjects or details that are not pertinent or to discover where more material is needed.

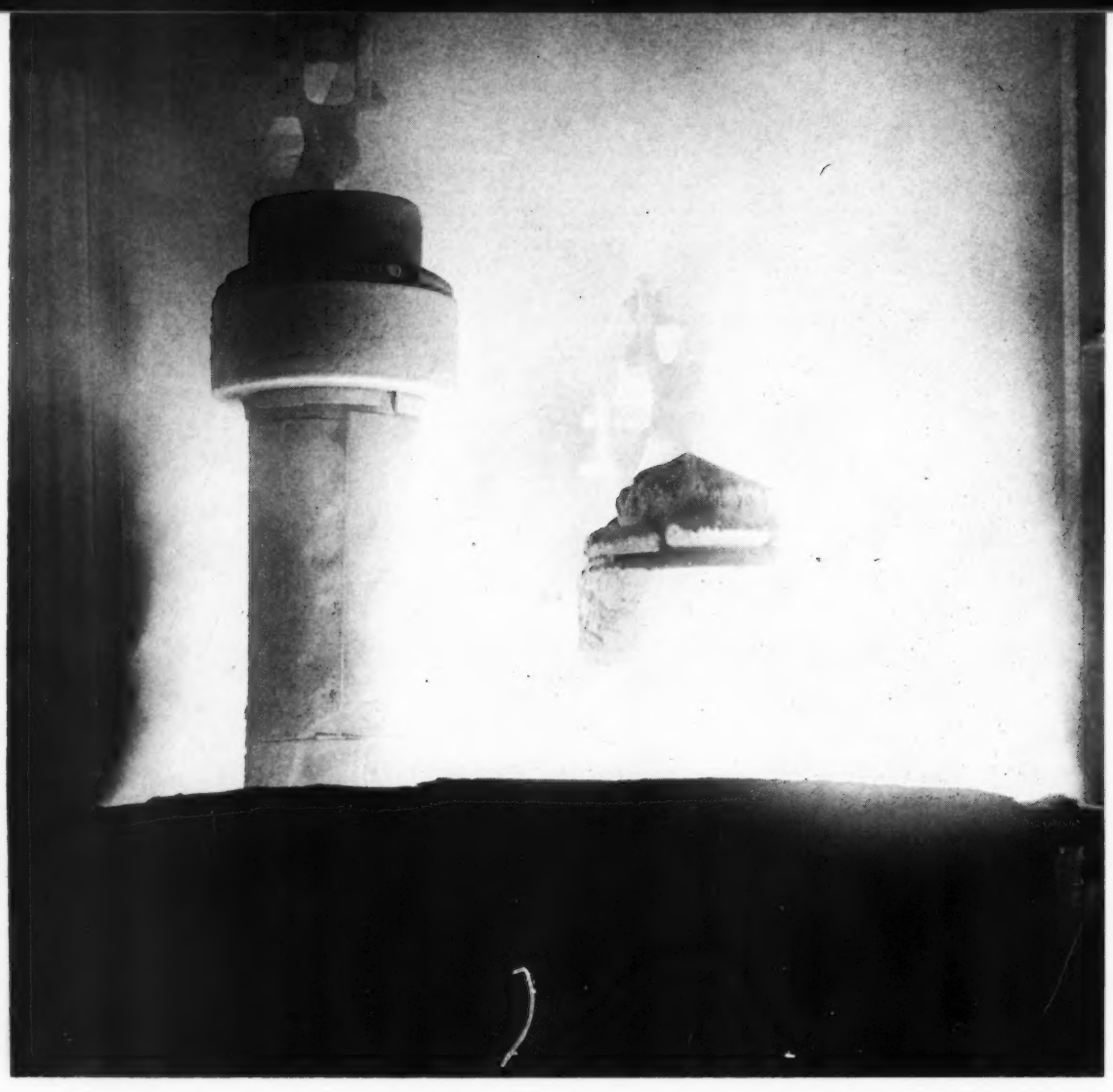
The cards should then be arranged into main groupings of related material. This procedure will lead to the discovery of overlapping or duplication, and it will bring into focus the major divisions of the finished report structure.

The author must decide what is the best sequence for presenting these major divisions. The pattern may resemble a flight of stairs, with one subject leading directly to the next, or it may resemble the spoke assembly of a wheel, with each subject presented independently — each from a different direction but all leading to one central conclusion. The nature of the job will determine this pattern.

Having established the sequence of the major divisions, the author must next organize the material already established as belonging to each group into subgroups of decreasing importance. The use of cards for listing of subjects facilitates arranging them within the organizational plan and determining their most suitable locations.

The author should at this stage of the procedure make every effort to establish the one pattern of organization that will achieve the objectives of the report most effectively, for it is rare that any two plans of presentation will be equally effective. Once this plan is known, it should be established as the report outline, including every major and minor topic heading, and the writing of the report should proceed in strict conformity to this outline.

Perhaps some engineers will feel that the time devoted to planning the report under the procedure suggested could be better spent in getting to work on the actual writing. Experience will show, however, that the time-cost involved in developing a sound plan of organization is a prudent expenditure, for if unsatisfactory arrangement of material can be discovered and rectified before the report is written, much of the time, labor, and expense usually required for revisions can be saved. The final report will be a better product and will better serve the client for whom it was written. ▲▲



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Zirconium — Metal With a Future

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CONSULTING ENGINEERS, especially in view of their increasingly active role in the engineering design of private atomic power plants, may find occasions when it is advantageous to have some grasp of the characteristics and applications of zirconium. This structural metal has the distinction of being the only commercially-available material with high mechanical strength and enough inertness to be used in the construction of many basic components of nuclear reactors. It combines two outstanding characteristics — low neutron absorption and high corrosion resistance.

Zirconium is the ninth metal in abundance in the earth's crust, being present in greater quantities than nickel, copper, zinc, tin, lead, or mercury. It is derived from two sources — principally zircon, found in beach sands throughout the world; and to a limited extent baddeleyite, found only in Brazil. Zircon or zirconium silicate ($ZrSiO_4$) is fairly plentiful in river beds and sea sands in many parts of the United States, but most of it comes from Florida beaches where it is available in vast quantities.

When commercial zirconium first was produced 30 years ago, it had the great disadvantage of costing $1800 a pound. By 1938, the price of the metal had dropped to a little less than $1000 a pound, and today commercial zirconium prices range upward from about $7.50 a pound. Forms now available include plate, strip, forgings, wire, and tubing.

PHYSICAL PROPERTIES OF ZIRCONIUM*

Density — lb/cu in., hot rolled	0.237
Density — lb/cu in., cold rolled	0.234
Approximate melting point — degrees F	3325
Thermal conductivity — Btu/hr/sq ft/ft/deg F at 250 F	8.46
Specific heat — Btu/lb/deg F at 70 F	0.067
Coefficient of thermal expansion/deg F — (70 - 390 F)	3.0×10^{-6}
Electrical resistivity — microhm-cms at 70 F	53-60
Electrical conductivity — percent of I.A.C.S. at 70 F	2.7
Temperature coefficient of resistivity/deg F — (32 - 212 F)	$14\text{-}16 \times 10^{-4}$
Modulus of elasticity — annealed	$11\text{-}14.8 \times 10^{6}$

*Commercial zirconium containing about 1.5 to 2.5% hafnium, 0.05 to 0.12% oxygen, 0.08 to 0.14% nitrogen, 0.06 to 0.30% carbon, 0.10 to 1.20% iron, 0.015 to 0.08% chromium, 0.002 to 0.02% nickel, and 0.01 to 0.03% silicon.

In its commercially processed form, zirconium is not chemically pure. It is an alloy containing about 2½-percent hafnium by weight. This has no appreciable effect for most services, since these metals have similar physical and chemical properties.

For nuclear applications, however, this universal association of hafnium and zirconium introduces complications since these two metals have diametrically opposite neutron absorption characteristics. Hafnium readily absorbs neutrons; it can be used in neutron absorbing control rods in atomic piles. Zirconium readily passes neutrons. Thus, both chemically pure hafnium and chemically pure zirconium are important to the atomic energy program, but effective separation is imperative.

Production Techniques

After separation, two methods currently are used to produce high purity zirconium; the iodide process (hot wire method) and the Kroll process. The iodide method requires metallic zirconium made by other processes, making the end-product costs prohibitively high for most commercial purposes. A modified version of the Kroll process currently is the predominant production technique. Briefly, this involves the reduction of previously purified, hafnium-free, zirconium tetrachloride with molten magnesium metal. Sponge, thus produced, is melted under a vacuum or a controlled atmosphere for use as massive zirconium.

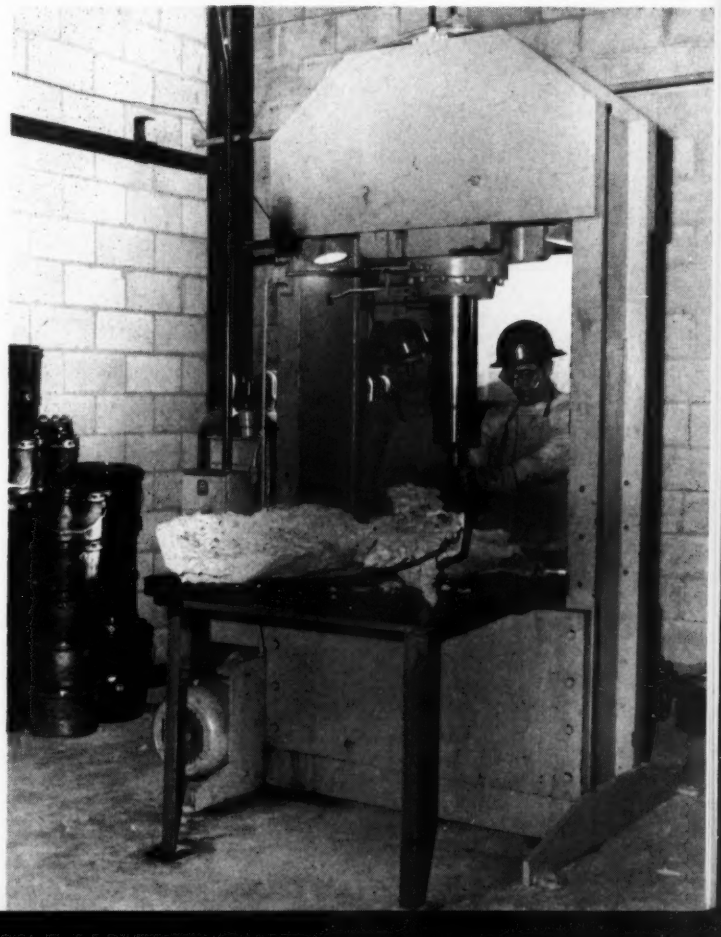
Commercial zirconium is produced in the same manner from hafnium-bearing zirconium tetrachloride. Some of the more important properties of commercial zirconium are shown in the tables. The density of the metal is intermediate between that of titanium and iron, or about 40 percent that of tantalum. This is important because zirconium is competing with tantalum for corrosion-resisting applications, where low density is often advantageous.

Its electrical resistivity and thermal expansion characteristics are analogous to the same properties in 410 stainless steel. The melting point is about 200 F above that of titanium and about 2000 F below that of tantalum, though this is of little significance because none of these materials can be used in open air at operating temperatures exceeding 1000 F for any considerable length of time.

Annealed zirconium has about the same tensile strength as 18:8 stainless steel plus comparatively high yield strength, but is harder and less ductile.

Increases in strength due to cold rolling also are not as marked with zirconium as they are with austenitic stainless steels. As indicated on the graph, the yield strength only increases from 60,000 to 102,000 psi with 50 percent cold reduction while

ZIRCONIUM SPONGE IS BROKEN AND CUT, AND THEN IT IS CRUSHED PRIOR TO THE MELTING OPERATION.



ELEVATED TEMPERATURE PROPERTIES ZIRCONIUM STRIP

Rockwell Hardness	Temperature degrees F	Tensile Strength psi	Elongation % in 2 in.
C 11.5	Room	87,000	16
	200	82,000	13
	400	67,000	14
C 26	Room	112,000	9
	200	102,000	8.5
	400	79,000	9.5

EFFECT OF OXYGEN AND NITROGEN ON STRENGTH OF ZIRCONIUM

Percent Oxygen and Nitrogen	Yield Strength 0.2% offset, psi	Tensile Strength psi
0.18	18,000	47,000
0.25	71,000	80,000

18:8 stainless steel increases from about 40,000 to 180,000 psi. However, zirconium loses ductility with comparative speed when cold worked, and it must be annealed with relative frequency.

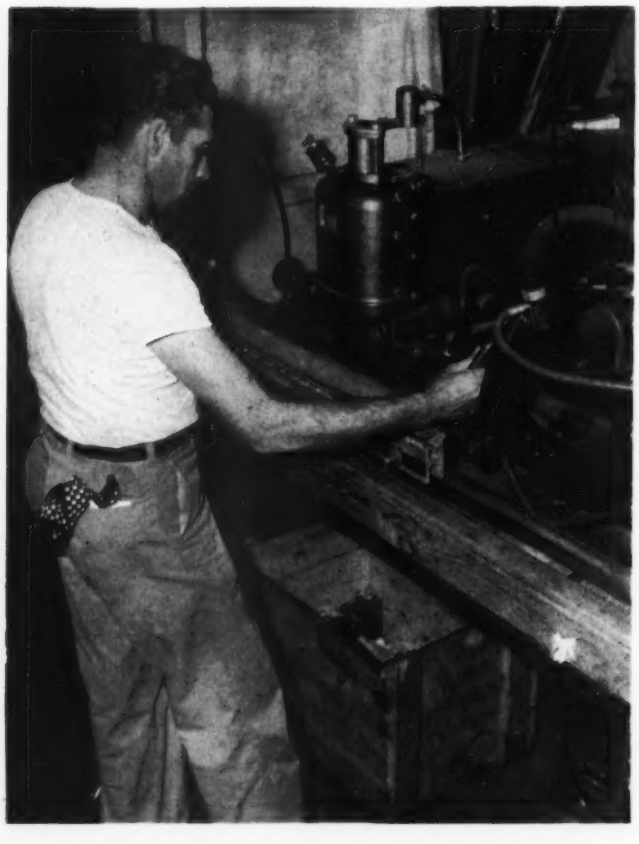
Zirconium's strength decreases quite rapidly at rising temperatures. For example, its room temperature tensile strength is reduced 50 percent when the metal is heated to 600 F. Elongation doubles, and there is an increase of approximately 15 percent in reduction of area at the same temperature.

Fabrication

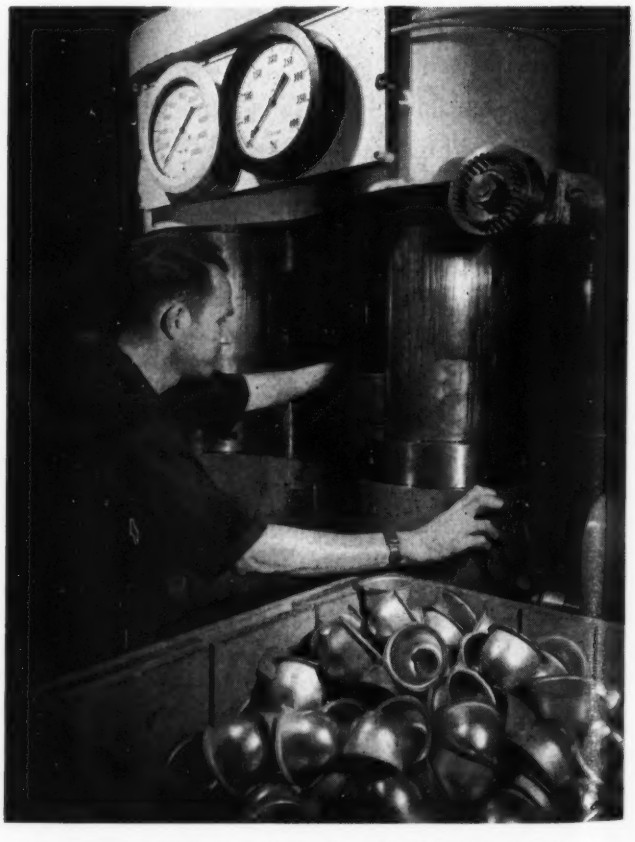
Although zirconium has a crystalline structure similar to that of magnesium, it can be fabricated at room temperature more easily than magnesium. With proper intermediate anneals, zirconium has been cold drawn into cups of considerable depth. Also, it has been spun cold, but in producing difficult shapes with bending operations, the best results have been obtained by preheating to temperatures of 400 to 600 F.

Because of its affinity for oxygen, nitrogen, hydrogen, and carbon at temperatures above 1000 F, zirconium is not an easy material to weld or cast. However, it has been processed satisfactorily with both resistance and heliarc welding facilities. Zirconium also has been cast with controlled atmosphere equipment the same as titanium.

From the industrial viewpoint, zirconium is perhaps most interesting because of its corrosion resistance. It is essentially as resistant as tantalum to most acids, and is superior to tantalum in alkali resistance. Zirconium has outstanding resistance to hydrochloric acid at temperatures through the boiling point; withstands sulfuric acid concentrations up to 80 percent; and is virtually impervious to all con-



ZIRCONIUM CAN BE WELDED SATISFACTORILY WITH BOTH RESISTANCE (ABOVE) AND HELIARC FACILITIES.



IF INTERMEDIATE ANNEALS ARE USED, ZIRCONIUM CAN BE COLD DRAWN INTO REASONABLY DEEP CUPS.

centrations of nitric and most organic acids. It also has excellent resistance to cold and hot sodium and potassium hydroxides at concentrations up to the molten salts; is not attacked by inorganic chloride solutions (except ferric and cupric chlorides, which embrittle the metal); and is almost as inert as tantalum in the presence of some halogens.

In the atomic energy field, zirconium's other outstanding characteristic — low neutron absorption — is of prime importance. Most of the current zirconium metal production is used in nuclear power applications. If some of the predictions that have been made in behalf of atomic energy are accurate, someday all zirconium metal production may be reserved for nuclear reactor components.

Applications

Meanwhile, the metal and its compounds already have a number of non-nuclear applications, particularly in the chemical and metallurgical fields.

¶ Zirconium is used extensively in the fabrication of pins, screws, and plates of the types used by surgeons in repairing human injuries because it is inert in the presence of body fluids, bone, and muscle.

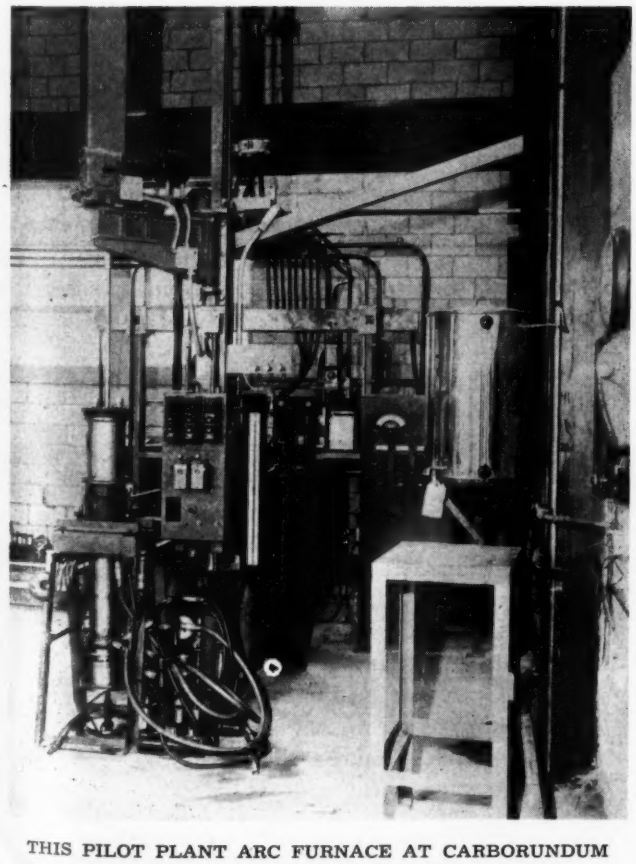
¶ Zirconium powder is excellent as a "getter" of oxygen in electronic tubes and as a primer for flashlight powders since it oxidizes readily at elevated temperatures.

¶ Zirconium spinnerets are utilized in Europe for spinning rayon because they resist both acid and alkaline processing solutions.

¶ Shaft sleeves, steam jets, and adapters for hydrochloric acid service are being made from zirconium.

Applications of various types should become especially numerous in the immediate future in the chemical industries, regardless of whether the price of the metal is appreciably reduced. Zirconium components can save considerable money in many circumstances simply by being relatively long-lived.

Tests recently conducted by the U. S. Bureau of Mines showed that aspirators built of zirconium components would remain usable for over two years in an atmosphere containing hydrochloric acid fumes. Brass components of the same types usually have to be replaced in less than a month. For this application, zirconium could be a better material than brass even if it cost 25 times as much. ▲▲



THIS PILOT PLANT ARC FURNACE AT CARBORUNDUM METALS PRODUCES INGOTS FROM ZIRCONIUM SPONGE.

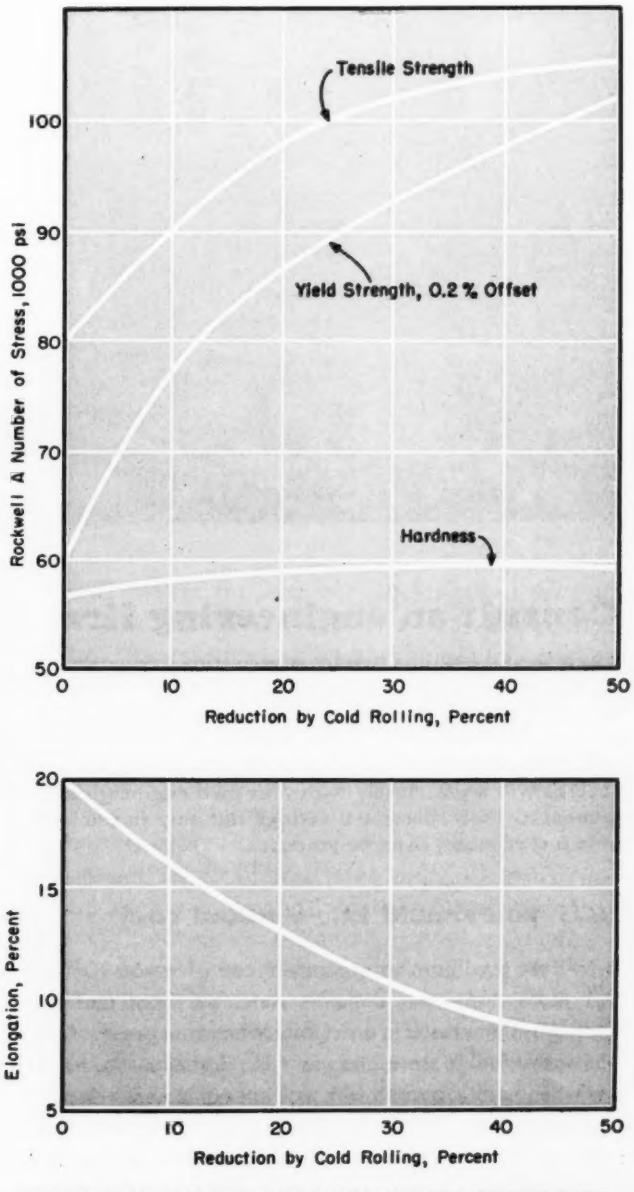
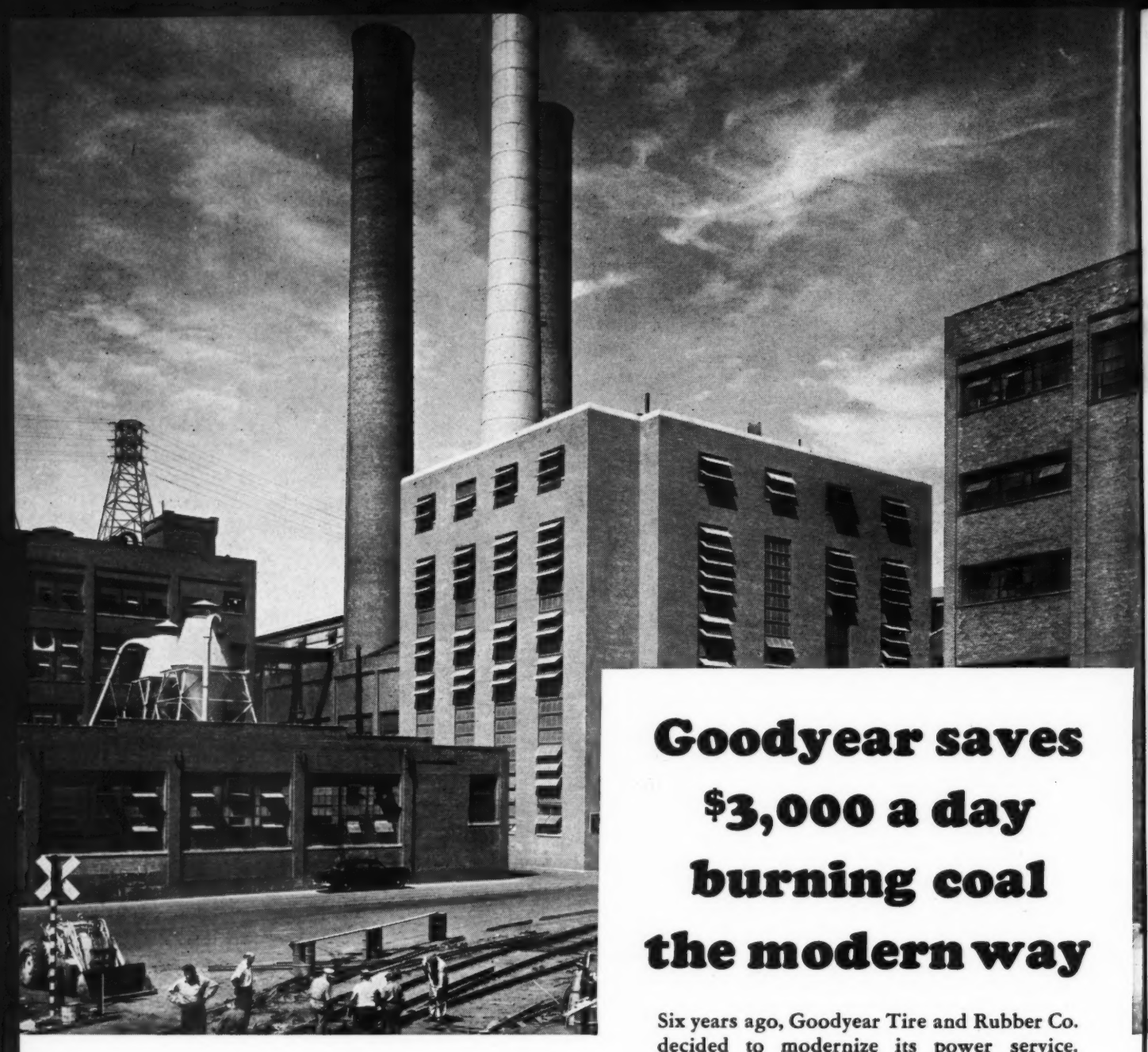


CHART SHOWS SOME OF THE MECHANICAL PROPERTIES OF COMMERCIAL ZIRCONIUM (COLD ROLLED STOCK).



Goodyear saves $3,000 a day burning coal the modern way

Six years ago, Goodyear Tire and Rubber Co. decided to modernize its power service. Among other considerations, 70% of the firm's steam-generating equipment was over 30 years old. As a result, operating efficiency was only 65%. Power needs at Goodyear's Akron plants ran so much greater than capacity that additional power had to be purchased. Goodyear engineers and engineering consultants, Sargent & Lundy, were called in to study the problem and recommend a solution.

Now two 220,000 lb.-per-hr. boilers have replaced six 50,000 lb.-per-hr. units. Coal and ash handling are automatic. Controls are fully automatic. And not only have these and other changes resulted in dependable power service, but steam generating efficiency is now 82%—saving Goodyear $3,000 a day. For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D.C.

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facts you should know about coal

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar • Automatic coal and ash handling systems result in a virtually labor-free plant • Coal is the safest fuel to store and use • No dust or smoke problems when coal is burned with modern equipment • In most industrial areas, bituminous coal is the lowest-cost fuel available • Between vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and it's price remaining stable.

Fee Schedules for Swiss Consultants

FRITZ HIRSCHFELD, European Editor

THE SWISS, in their systematic and orderly tradition, have carefully established and defined the fees that the members of the Association of Consulting Engineers are permitted to charge their clients. This schedule of fees applies primarily to consulting work on construction projects. It includes five general classifications to take into consideration the varying amount of experience, technical know-how, and responsibility necessary to properly handle different types of engineering assignments.

Construction Project Classifications

Each of the five classifications defines in broad terms the types of engineering assignments that fall within its particular category.

Class I includes projects such as: simple roads and highways in flat open country involving no special or complicated design features; standard type buildings; and the commonly used water supply and sewage disposal systems as found in the more rural areas.

Class II covers projects calling for more specialized knowledge and experience in the construction of roads, bridges, and railways in rolling country and urban areas. Warehouses, industrial plants, building foundations, and water supply and disposal systems for urban areas also fall under this category.

Class III embraces projects such as: tunnels and railways in mountainous country; complex industrial buildings, bridges, and aqueducts featuring difficult engineering problems; port and dock construction; and simple dams and hydroelectric stations.

Class IV involves consultants engaged in construction projects such as: thermal power plants and underground factories; high voltage power transmission lines; and large dams and hydro stations. It includes specialized techniques as might be called for in the construction of caissons for underwater foundations.

Class V is the top category, and it is reserved for the most highly specialized and difficult engineering problems. Here too, in many instances, the engineer also must assume the responsibility for the expendi-

TABLE 1 — SWISS FEE SCHEDULES

Total Construction Cost in Swiss Francs	The Fee as a Percent (P) of the Construction Cost				
	Class I	Class II	Class III	Class IV	Class V
30,000	12.57	14.27	15.97	17.67	19.37
40,000	11.53	13.23	14.93	16.63	18.33
50,000	10.80	12.50	14.20	15.90	17.60
60,000	10.24	11.94	13.64	15.34	17.04
70,000	9.79	11.49	13.19	14.89	16.59
80,000	9.42	11.12	12.82	14.52	16.22
90,000	9.11	10.81	12.51	14.21	15.91
100,000	8.84	10.54	12.24	13.94	15.64
150,000	7.89	9.59	11.29	12.99	14.69
200,000	7.29	8.99	10.69	12.39	14.09
300,000	6.53	8.23	9.93	11.63	13.33
400,000	6.05	7.75	9.45	11.15	12.85
500,000	5.71	7.41	9.11	10.81	12.51
600,000	5.45	7.15	8.85	10.55	12.25
700,000	5.24	6.94	8.64	10.34	12.04
800,000	5.07	6.77	8.47	10.17	11.87
900,000	4.93	6.63	8.33	10.03	11.73
1,000,000	4.80	6.50	8.20	9.90	11.60
2,000,000	4.08	5.78	7.48	9.18	10.88
3,000,000	3.73	5.43	7.13	8.83	10.53
4,000,000	3.51	5.21	6.91	8.61	10.31
5,000,000	3.35	5.05	6.75	8.45	10.15
6,000,000	3.23	4.93	6.63	8.33	10.03
8,000,000	3.05	4.75	6.45	8.15	9.85
10,000,000	2.93	4.63	6.33	8.03	9.73
15,000,000	2.72	4.42	6.12	7.82	9.52
20,000,000	2.59	4.29	5.99	7.69	9.39

Note: Approximately 4.25 Swiss Francs = $1.00 (U.S.)

ture of large sums of money as well as considerations that may involve public safety. Subways; foundations for heavy machinery like large turbines; complicated hydroelectric installations; and large water purification or waste treatment plants come under this classification for complicated projects.

Primary Fee Schedule

When a consulting firm is responsible for the over-all engineering on any project in these classifications, the fee is a fixed percentage of the total construction cost. This percentage varies with the size of the project and the type of work as shown in Table 1, which was calculated from the following formula:

$$P = C + (35 \div \sqrt[3]{B}), \text{ where:}$$

P = the fee as a percentage of the construction cost
C = a constant for *Class I* work = 1.3
C = a constant for *Class II* work = 3.0
C = a constant for *Class III* work = 4.7
C = a constant for *Class IV* work = 6.4
C = a constant for *Class V* work = 8.1
B = construction cost in thousands of Swiss Francs

For any given size project, factor $35 \div \sqrt[3]{B}$ is obviously constant. For example, on a 500,000 franc job:

TABLE 2 — PERCENT BREAKDOWN OF THE TOTAL FEE FOR SERVICE PERFORMED

Construction Costs in Swiss Francs	Up to 100,000	100,000 to 1,000,000	Over 1,000,000
Preliminary Plans and Estimates	6	5	4
Static/Hydraulic Calculations	17	17	17
Detailed Drawings and Specifications	24	23	22
Preparing Construction Contracts and Checking Bids	3	3	3
Over-all Construction Supervision	12	13	14
Field Inspection and Supervision	31	32	33
Final Review and Work Completion	7	7	7
	100%	100%	100%

Note: Approximately 4.25 Swiss Francs = $1.00 (U.S.)

TABLE 3 — FEE SCHEDULE ADJUSTMENT FACTORS FOR A NUMBER OF IDENTICAL CONSTRUCTION PROJECTS

Number of Identical Projects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15 or More
Corresponding V-Factor	—	.75	.65	.58	.54	.51	.48	.47	.46	.45	.44	.43	.42	.41	.40

$B = 500$; $\sqrt[3]{B} = 7.937$; and $35 \div 7.937 = 4.41$. However, as can be seen by the increasing values of the five classification (C) constants, the total percentages (P) that determine the fees are graduated in a straight-line relationship to give an increased compensation for the more advanced and complicated types of engineering assignments.

Partial Participation

Frequently a consultant will be called upon to do only a limited part of the engineering for an entire project. Under these circumstances, he is entitled to charge a percentage of the total fee (corresponding to the cost of the over-all construction as determined from Table 1) that is commensurate with the extent of his own participation. This percentage is defined in Table 2. It should be added that there is enough flexibility in these fee determinations, covered in detail both by written regulations and by precedents, to allow the Swiss consultant to take into account the many variations that are bound to come up with different jobs, while still conforming to the fee pattern established by the Association.

Multiple Construction Projects

Table 3 is used when the consulting engineer is responsible for two or more identical projects; for example, a series of identical warehouses. His fee then would be his normal percent of the over-all construction cost (from Table 1) multiplied by the V-factor (Table 3). The V-factor decreases as the number of duplications increases.

Personnel and Overhead Fees

As another method of determining his fee, the consulting engineer may base his charges on the amount of time that he is involved on a project. If the consultant is called in for an opinion, specialized advice, expert testimony, or other forms of consulting service that obviously do not fall into the previous fee schedules, he can base his fee on the personnel and overhead charges as shown in Table 4. In other words, he would tabulate the number of hours contributed to the project by each personnel group and multiply these hours by the corresponding daily charges as shown in Table 4. This sum then would be the fee chargeable to the client.

The fee schedules, along with all the necessary definitions and determinations for their proper application, are published in booklet form. They are available to all interested parties and potential clients. Taking into account the fact that the personnel charges in Table 4 have been increased by 100 percent to cover overhead, the approximate earnings of a Swiss consulting engineer and the pay of his employees become common knowledge. The schedules are revised and brought up to date periodically, the last revision having been made in October, 1951. Suggested changes must be approved by the delegates of the Swiss Association of Architects and Engineers (Schweizerischer Ingenieur-Und Architekten-Verein) before becoming effective.

Results

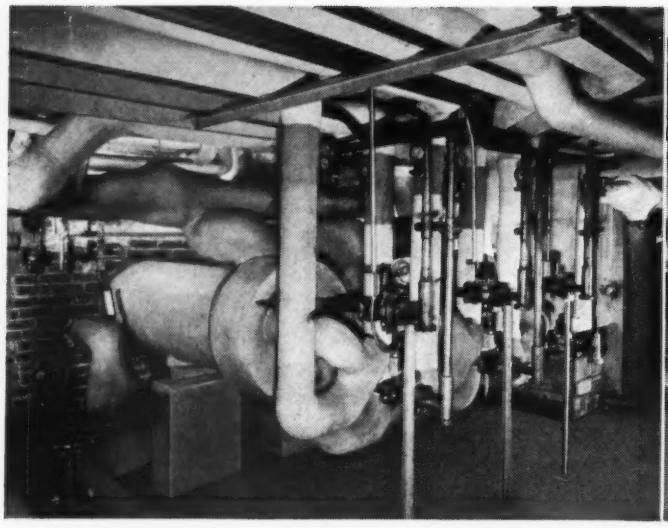
By setting up and enforcing a fee schedule (as is also the general practice in most of the consulting engineering Associations in the other European countries), the Swiss have practically eliminated one of the biggest professional ethical headaches—fee-cutting. Since the fee would be the same among different consultants for any given project, the client can make his choice of a consulting engineer solely on the basis of the man's qualifications, reputation, or other personal factors.

But one serious problem still remains—what to do about the consulting engineer who operates outside of the Association and is not bound by the fee schedule. The members readily admit that there's very little they can do about this situation. However, the Association does feel that in due time the industrial clients who support this fringe consultant will realize that there is no substitute for reliable experience and background and will further recognize that the lower fee of the marginal operator can only mean a lower standard or quality of work. ▲▲

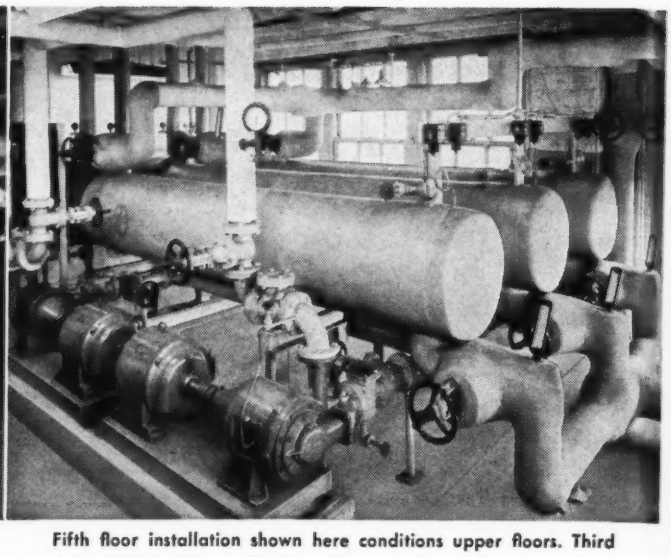
TABLE 4 — PERSONNEL AND OVERHEAD CHARGES FOR EIGHT HOUR DAY IN SWISS FRANCS

Personnel Categories	Charges
Consulting Engineer (Owner or Partner)	160
Chief or Managing Engineer	135
Engineer Squad Leader/Designer	110
Assistant Engineer/Designer	90
Draftsman and Specifications Writer	70
Other Technical Office Help	60

For work outside home office area charges increase 30%.
For work outside country charges increase 40%.
For work overseas charges increase 50%.
Note: Approximately 4.25 Swiss Francs = $1.00 (U.S.)



These three p-k Freon coolers, located in the basement, protrude through brick wall to save space.



Fifth floor installation shown here conditions upper floors. Third floor chillers serve cooling tunnels.

for perfect candy kitchen weather

LOFT'S USES p-k COOLERS

Schwerin Air Conditioning Corp. specified Chrysler Airtemp Units with p-k chillers to keep Loft's 8-story Long Island candy kitchen at just the right temperature and humidity for candy perfection.

You've seen soft, stieky, unappetizing candy you wouldn't want to eat. But you won't see it at Loft's. This big Eastern candy manufacturer has an unusual ability for maintaining the highest standards of quality 'buy-appeal'. And one important reason is its thorough-going air conditioning system employing Chrysler Airtemp units and six p-k dry expansion Freon coolers, engineered and installed by Schwerin Air Conditioning Corp., New York.

At Loft's both humidity and temperature must be rigidly controlled, for when humidity gets out of hand, candy is unsaleable.

So the reheating principle is used to cool the air, and "wring" it to the proper humidity. "Two-circuit" type p-k Freon coolers which chill a glycol solution are located in the basement and the third and fifth floors, to serve nearby areas. Air from conditioned areas passes around coils chilled by the glycol solution and air temperature is reduced some 25°F. to 43°F. A water spray cleans the air, and increases its humidity to 97%. Then the air is circulated around heating coils where its temperature is raised to 60°F. and humidity reduced to 51%—just the right "weather" for perfect candy-making.

The six p-k Freon coolers are automatically controlled; operation is simple. Because the coolers are enclosed, the Loft system is a *clean* system. Compact p-k Freon coolers require minimum floor space, minimum insulation.

If you, like Loft's, have a tough "indoor weather" problem, p-k heat exchange specialists would be glad to assist. More than likely they'll have answers to your particular questions. Write today for illustrated literature and engineering suggestions.

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SANDBLASTING IS ONE METHOD OF SURFACE PREPARATION. NOTE DIFFERENCE IN CLEANED AND UNCLEANED AREAS.

Preparing Specifications For The Painting of Steel Structures

JOSEPH BIGOS
Senior Fellow, Mellon Institute
Director of Research, Steel Structures Painting Council

Joseph Bigos attended the University of Pittsburgh, receiving a B.S. degree in Chemical Engineering in 1939, an M.S. degree in 1940, and, following an extended period of military service, a Ph.D. degree in 1948. While with the Transportation Corps of the U. S. Army, where he rose to the rank of Major, he had considerable experience in ship repair and marine work, including drydocking, cleaning, and painting of ships and floating equipment. From 1946 to 1951, he taught at the University of Pittsburgh, becoming an Assistant Professor for the last two years of his tenure. During this period he also worked on the design and construction of pilot plant equipment for the chemical engineering laboratory and as a consulting chemical engineer. Since 1951 he has been Senior Fellow of Mellon Institute and Director of Research of Steel Structures Painting Council. He is a member of Sigma XI, Sigma Tau, and Phi Lambda Upsilon; a registered professional engineer in Pennsylvania; and a member of the American Institute of Chemical Engineers, American Chemical Society, and the National Association of Corrosion Engineers.

FEW CONSULTING ENGINEERS or architects are well enough versed in paint technology to qualify them as specialists. All of them, however, readily can learn enough about corrosion of steel and protection by paint to properly specify the protective painting of new structures. This is now particularly easy as a result of work done by the Steel Structures Painting Council — an organization supported by many technical associations and devoted to studying the best methods of painting steel structures.

Two recent publications* provide the necessary background and detailed recommendations to equip consultants and architects with the tools for correctly specifying painting of new steel. The first volume is an encyclopedia of authoritative information on all phases of cleaning and painting, including

*Bigos, J., *Steel Structures Painting Manual, Volume 1 — Good Painting Practice*, published 1954, *Volume 2 — Systems and Specifications*, published 1955, Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh 13, Pennsylvania.

materials to use, techniques, and other pertinent data. The second volume is a specific guide and index of recommended painting systems for a great number of steel structures in many different exposures, including specifications covering all phases of cleaning and painting.

Guard Against Corrosion

Corrosion — the destruction of metal by chemical or electrochemical reaction with its environment — greatly influences painting specifications. Two general types of corrosion occur: direct chemical oxidation and electrochemical corrosion. In direct oxidation, corrosion occurs by chemical reaction of metal with gas, such as the initial reaction of iron with oxygen to form iron oxides. At normal temperatures, the film of iron oxide is protective and corrosion ceases. At high temperatures, direct oxidation continues at a high rate.

In contrast to direct oxidation in which the reactions occur through direct interchange of electrons, electrochemical corrosion occurs in the presence of water. Electrons given up by the corroding iron then flow through a metallic or conducting path to another area where the electrons combine with other ions and form corrosion products. An electric current is generated in the process. As a result, corrosion occurs at anodic areas and protection is afforded at cathodic areas. Electrochemical corrosion may be quite drastic even at normal temperatures. Rusting of steel is electrochemical corrosion, and it continues as long as oxygen and water are both available. Note that both must be available.

Bright, clean steel may be exposed to dry at-

SPECIFICATIONS FOR CLEANING AND PAINTING STEEL STRUCTURES

Specification	Subject	Contents
	Surface Preparation Specifications	
SSPC-SP 1-52T	Solvent Cleaning	Covers solvent wiping, immersion, end spraying; vapor degreasing; alkaline, emulsion, and steam cleaning; paint stripping. Removes oil, grease, dirt and soil, salts, and residues of contaminants. Rust and mill scale not removed.
SSPC-SP 2-52T	Hand Cleaning	Covers hand chipping, scraping, sanding, and wirebrushing. Removes loose rust, loose mill scale, and loose paint to degree specified.
SSPC-SP 3-52T	Power Tool Cleaning	Covers power tool chipping, descaling, sanding, wirebrushing, and grinding. Removes loose rust, loose mill scale, and loose paint to degree specified.
SSPC-SP 4-52T	Flame Cleaning of New Steel	Covers flame dehydrating and cleaning followed by wirebrushing. Removes rust, loose mill scale, and some tight mill scale.
SSPC-SP 5-52T	Blast Cleaning to "White" Metal	Covers nozzle (dry, wet, or vapor) or centrifugal blast cleaning using sand, synthetic abrasives, crushed iron or steel grit and shot. Completely removes all rust, mill scale, paint, and foreign matter.
SSPC-SP 6-52T	Commercial Blast Cleaning	Covers above blast cleaning but removes rust and mill scale only to degree specified. Slight residues of tight rust and mill scale remaining are generally tolerable.
SSPC-SP 7-52T	Brush-Off Blast Cleaning	Covers above blast cleaning but removes considerably less rust and mill scale. Considerable residues of tight rust and mill scale are generally tolerable for less severe exposures particularly with good wetting primers.
SSPC-SP 8-52T	Pickling	Covers sulfuric, hydrochloric, and phosphoric acid pickling; duplex pickling and electrolytic pickling. Completely removes rust and mill scale; some operations passivate the surface.
SSPC-SP 9-52T	Weathering	Covers exposure to weather to remove mill scale by rusting. Leaves considerable rust and residue of mill scale. Must be followed by other cleaning methods. Commercial blast cleaning recommended.
	Pretreatment Specifications	
SSPC-PT 1-53T	Wetting Oil Treatment	Covers application of wetting oils to surfaces, from which all rust and mill scale have not been removed, to improve adhesion and bond of paint.
SSPC-PT 2-53T	Cold Phosphate Surface Treatment	Covers application of phosphoric acid treatments to passivate steel surfaces which have been thoroughly cleaned.
SSPC-PT 3-53T	Basic Zinc Chromate Vinyl Butyral Washcoat	Covers application of wash primer to thoroughly cleaned steel; improves adhesion and bond of paint; reduces underfilm corrosion.
SSPC-PT 4-53T	Hot Phosphate Surface Conversion	Covers hot conversion by zinc or iron phosphate solutions to form crystalline surface for improvement of paint bonding and reducing of underfilm corrosion.
	Paint Application Specifications	
SSPC-PA 1-53T	Shop, Field, and Maintenance Painting	Completely covers all phases of paint storage, mixing, thinning, application by brush or spray in shop or field, permissible temperatures and humidities, drying, and protection of painted steel.

mospheres for extremely long periods of time with little or no evidence of rusting; no protective coating is necessary to retard corrosion. However, when the relative humidity of the air reaches about 70 percent at ordinary temperatures rusting begins. This is referred to as the critical humidity. Above 70-percent relative humidity, rusting can be severe; below 70 percent it is inconsequential.

Consider the Service Exposure

Service exposure must be taken into account when specifying paint protection for steel. Painting for the sake of protection alone normally cannot be justified for structural steel exposed to dry or arid atmospheres. It also is quite often difficult to justify the cost of painting building interiors only on the basis of required protection. Similarly, for building frames that will be enclosed in masonry or encased in concrete, painting is unnecessary as long as water is excluded. This is not an unreasonable expectation of present building construction.

Exposed steel in the interior of a building with an atmosphere below 70-percent relative humidity does not rust. Slight corrosion may occur, but it cannot be considered structurally detrimental. Painting often is done for the sake of good appearance rather than for protection alone. As the humidity increases the need for protection increases. At very high humidity, particularly in the presence of corrosion accelerating agents such as sulfur dioxide or salt, the need for protection may demand good, and usually expensive, painting. Each project requires individual evaluation, and the painting program should take cognizance of both the service conditions and the desired results.

Prepare Complete Specifications

The most important factors to cover in specifications to assure good service from paint systems are:

¶ Proper design to minimize corrosion and paint failure and to facilitate repainting.

¶ Preparation of the surface to a degree consistent with the intended service exposure and requirements of the priming paint to be used.

¶ Correct application of paint in a manner to insure maximum paint life but yet one commensurate with practical difficulties.

¶ Selection and use of paints that are formulated properly and can perform the required service.

Careful attention to detail can do much to reduce the potential of corrosion and paint failure. Proper designs should eliminate surfaces that collect and hold water, and should minimize cracks, crevices, and sharp projections such as corners, angles, and rivet heads. They should provide accessibility for repainting — particularly sufficient space for good inspection, cleaning, and application. Bad features, such as angles back-to-back but separated by spacers should be avoided. For example, T bars can be substituted advantageously. Every structural designer should know in advance how each surface can be repainted — preferably easily and at low cost.

Hot rolled structural steel has a layer of blue mill scale, which is a mixture of iron oxides. This mill scale, when intact, provides a good base for painting if the steel will not be immersed in strong electrolytes, such as salt water. Upon handling, fabricating, and exposure to the weather, mill scale becomes cracked and broken and, in the weathering process, becomes undercut by rust so that the scale lifts from the surface. As a result it is a poor surface to paint over, since the mill scale often is partially undercut by rust and will sometimes lift after painting. The procedure of weathering to remove mill scale is not recommended unless it is followed by blast cleaning to remove the rust.

Beware of Rust

Rust probably is the worst surface to paint over. No known method of painting has been successful when rust is the substrate. Removal of rust is mandatory, even though comparatively ineffective methods such as chipping and hand wire brushing are used. Weathering to remove mill scale is sometimes desirable when the steel is to be later exposed in a strong electrolyte where devastating corrosion could occur at breaks in the mill scale, i.e., ship bottoms—but blast cleaning or pickling are not feasible.

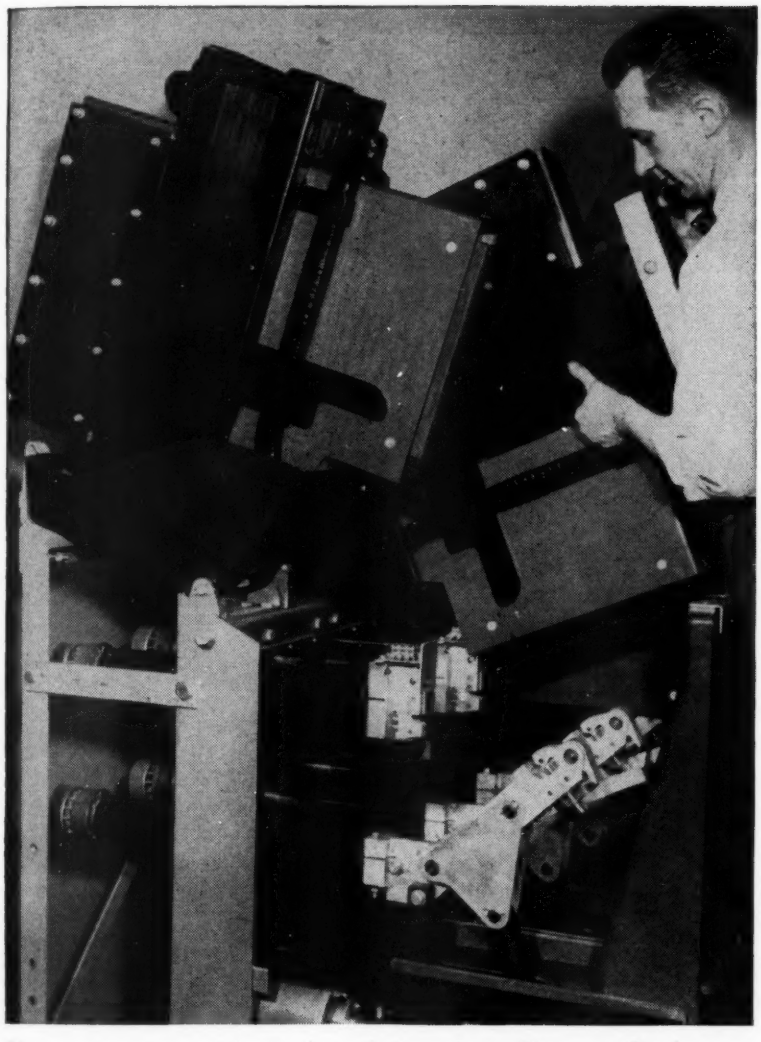
For normal atmospheric exposures, conscientious hand or power tool cleaning to remove loose mill scale and rust as well as oil, grease, and soil is adequate as the surface preparation, provided primers of sufficient wetting ability are used. It is not necessarily the most economical method when figured on the basis of cost per square foot per year, but it results in a lower initial painting cost. When the structure becomes stabilized so that no mill scale lifting occurs, the life of the protection becomes a function of the durability of the paints. Repainting may be governed by other considerations such as appearance.

Nine Paint System Specifications of the Steel Structures Painting Council, each developed for a separate exposure classification, cover the painting of most steel structures. Each paint system is complete; the specification stipulates the surface preparation, pretreatment, paint application, primers, and intermediate and finish paints by reference to separate specifications for each item. Detailed requirements such as dry paint film thickness, drying time, color contrast between coats, and other necessary information are included. If the paint system number only is specified, a "standard" system is supplied. If particular primers, finish coats, or surface preparations are desired, the consultant may specify any of numerous "alternates" to cover almost every possible situation. The following table lists the data included in each SSPC specification. ⟶

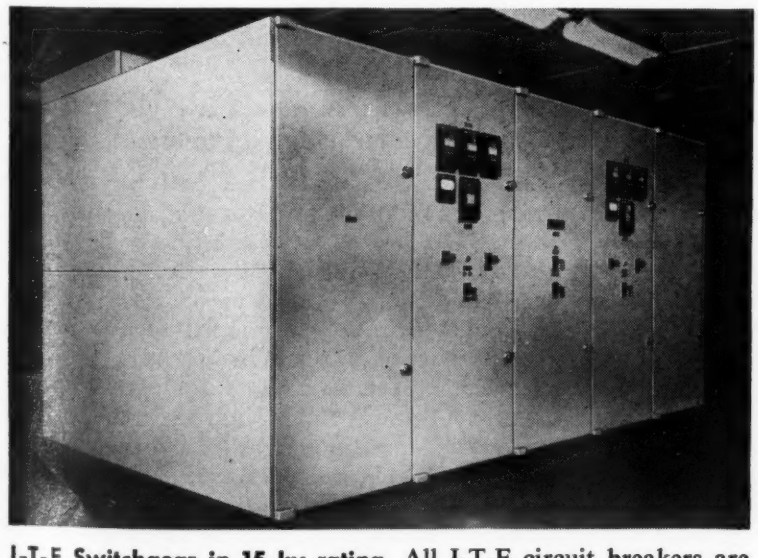
GUIDE FOR SPECIFYING THE PAINTING OF STEEL STRUCTURES

Surface To Be Painted	*Recommendations*	*Details Of SSPC Paint Systems*
Classification—Dry, Interiors		
Structural steel enclosed in masonry, or encased in concrete or dry fireproofing; inside of dry buildings with noncorrosive atmospheres; exposed to the weather in arid climates, or requiring only temporary protection from the weather for periods not exceeding about six months in rural, urban, or light industrial environments. If good bonding between steel and concrete is required, do not paint encased steel. Examples: Weathertight building frames and floor joists not subjected to condensation; garages, warehouses, industrial buildings in which the temperature rarely falls below the dew point; steel in dry void spaces or below 70% relative humidity, no abnormal or corrosive environment.	Use SSPC-PS 7-55T, "One-Coat Shop Paint System for Structural Steel." In view of the noncorrosive conditions, a higher degree of cleaning and painting is not warranted. If finish painting is contemplated, the first 3 primers in PS 7 may be used under the intermediate and finish paints in PS 1.	Paint System No. 7 provides low cost initial painting; is economical for the noncorrosive service for which it is intended. A nominal cleaning to remove loose mill scale, loose rust, weld slag, rust scale, and heavy deposits of oil, grease, and soil is all that is required. The standard shopcoat paint is one coat of SSPC-Paint 13-55T (iron oxide - ester gum varnish - linseed oil containing some red lead and zinc chromate). Alternate primers that may be specified are: Federal Specifications TT-P-636b (iron oxide - zinc chromate - alkyd); TT-P-31b (iron oxide - zinc oxide - linseed oil); TT-V-51a (asphalt varnish). The last is not suitable for decorative painting.
Classification—Normally Dry but Exposed to the Weather		
Structural steel exposed to the weather in rural, industrial, or marine atmospheres; but normally dry and not exposed to very corrosive chemical fumes or gases from heavy industrial or chemical plants; nor subjected to immersion, continuous high humidity, or continuous condensation. Examples: Bridges, tank exteriors, towers, structural members, trestles, platforms, crane runways, poles, derricks, dam superstructures.	Use SSPC-PS 1-55T, "Oil Base Paint Systems for Weather Exposed Steel." This system will embrace the great preponderance of structural steel painting. SSPC-PS 2-55T, "Alkyd Paint Systems for Weather Exposure, High Humidity, and Infrequent Immersion," may be used in place of PS 1; the better cleaning called for in PS 2 in conjunction with the alkyd paints gives longer paint life in the more severe environments.	Paint System No. 1 requires good cleaning; minimum surface preparation is hand or power tool cleaning per SSPC specifications. Four standard heavy duty primers are included: SSPC-Paint 1-55T (red lead - raw linseed oil); Federal Specification TT-P-86a, Type I (red lead - raw and bodied linseed oils); SSPC-Paint 2-55T (75% red lead/25% iron oxide - 2 linseed oil/1 alkyd); SSPC-Paint 3-55T (75% red lead/25% iron oxide - fractionated linseed oil). Alternate primers are: TT-P-641b, Type I (zinc dust - zinc oxide - raw linseed oil)—good for galvanizing; SSPC-Paint 4-55T (extended red lead - linseed oil); Federal Specification TT-P-57, Type I (zinc chromate - yellow iron oxide - linseed oil - alkyd); SSPC-Paint 11-55T (same as TT-P-57, Type I, but red color); Federal Specification TT-P-86a, Type II (extended red lead - iron oxide - linseed oil - alkyd); AASHO-M72-51, Type IV (red lead - linseed oil - alkyd). The standard system consists of 2 coats of primer and a finish coat of aluminum, but numerous alternate oil, alkyd, and phenolic intermediate and finish paints are included.
Classification—Frequently Wet or Exposed to High Humidity		
Structural steel that is frequently but not continuously wet; exposed to the weather or to high humidity, but not exposed to continuous condensation; infrequently immersed in fresh or salt water; exposed to heavy industrial air. Examples: Bridges, tanks, and buildings in highly humid regions such as wet coastal areas; interiors of canneries or processing plants where condensation is not continuous; topsides of ships; superstructures of fresh or salt water vessels; equipment or machinery that requires high gloss or hard finishes, or is frequently washed with steam or detergents; production items of lightweight metal requiring quick drying paints; structures adjacent to heavy-industry plants.	Use SSPC-PS 2-55T, "Alkyd Paint Systems for Weather Exposure, High Humidity, and Infrequent Immersion." For best results, blast clean or pickle; flame cleaning, power tool cleaning, or hand cleaning will give increasingly poorer results, but may be adequate particularly in maintenance painting. Wetting oil pretreatment recommended for residual rust, cracked mill scale; wash primer or hot phosphate for descaled steel.	Paint System No. 2 requires particularly good cleaning. Commercial blast cleaning or pickling is standard, due to limited wetting of primers; but alternative methods of surface preparation also may be specified. Standard primers are: Federal Specification TT-P-86a, Type III (red lead - alkyd); Federal Specification TT-P-57, Type II, (yellow iron oxide - zinc chromate - alkyd); Military Specification JAN-P-735 or Maritime Administration 52-MA-202 (zinc chromate - titanium dioxide - alkyd); Military Specification MIL-P-17545 or Maritime Administration 52-MA-201a (red lead - zinc chromate - extenders - alkyd). A zinc dust primer alternate (excellent for new galvanizing) is Federal Specification TT-P-641b, Type II. Alkyd intermediate and finish paints are listed. They include bright colored glossy, semigloss, or lustreless finishes for equipment, machinery, trim, walls, etc.

Note: SSPC-PS 3-55T also may be used for this class, particularly in the very wet environments, or where mild chemical exposure or oil and grease also are encountered.



No cranes are required. Arc chutes pivot. Rest on fixed stop. Illustration shows 15 kv magnetic air circuit breaker.



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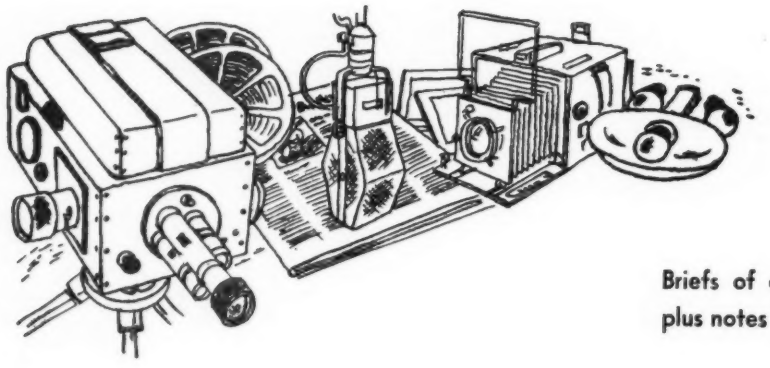
Note: 33PC-PS 3-551 also may be used for this class, particularly in the very wet environments, or where mild chemical exposure or oil and grease also are encountered.



NEWS

Briefs of current interest to the consulting profession plus notes on new equipment in the field of engineering

CE's Prepare Plans For New Power Plants

Power plants of the future may be atomic powered but the "here and now" requirements for additional electric power must be met by new, conventional plants as evidenced by the number of cities and states now making plans to increase their facilities.

Preliminary studies leading to selection of a site and construction of a new $1 million power plant for Memphis, Tenn. are being made by Burns & Roe, Inc., of New York City, for Memphis Light, Gas & Water Commission. The Commission expects to begin construction by January 1, 1956.

Power loads and load growth will be studied and recommendations made on size of plant, turbines and generators, and available plant sites. Soil foundation and estimates of cost of construction and operation will be included in the report. Burns & Roe will also prepare contracts for construction, design the plant, and supervise construction.

A three man consulting board has been retained by the Sacramento Municipal Utility District to review the proposed 200,000 kw Upper American River Hydro-Electric Project before the District authorizes sale of a $85 million revenue bond issue, to finance the project.

The preliminary reports were prepared by Frank E. Bonner, a San Francisco consulting engineer. Members of the three man reviewing board are: John S. Longwell, of Oakland; I. C. Steele, of San Francisco; and Chester Marliave, of Berkeley.

A six-point program for marketing St. Lawrence power, including establishment of a Vermont power pool, has been drawn up by Leland Olds, former chairman of the Federal Power Commission and now a consultant with Energy Resources Associates. The plan was prepared by Olds at the request of the Vermont Electric, Washington Electric, and Halifax Electric Cooperatives.

The plan is estimated to save Vermont consumers $4-½ million annually. The major proposal, the power pool, would combine the major power supply system concerned with intrastate power, augmented by additional transmission facilities, from St. Lawrence power into Vermont and into the grid system. These would include additional transmission facilities for New York State to Milton and down the west side of the state to Rutland.

Houston Plans Technical and Scientific Center

Plans for a Technical and Scientific Center for the city of Houston, Texas, have been announced by the Houston Engineers Club, which will sponsor the Center. It will provide space and professional services for the more than 9000 members of the city's 35 technical societies and engineering groups.

A $300,000 remodeling job will convert the present Engineers Club building into lecture halls, conference rooms, dining rooms, offices for affiliating associations using the Center, and a reading and reference room. There will also be a general correspondence and secretarial service to handle mailings, typing, and correspondence of the associations using the facilities. Displays of new ideas and developments in engineering and science will be maintained, and an engineering employment service will be provided.

To finance the remodeling and furnishing, the Houston Engineers Club has authorized a $300,000 bond issue, more than half of which has already been subscribed by individual members of the Club.

New Polyethylenes Promise Advances In Structural and Fabricated Parts

The use of the new polyethylenes will bring about great transformations in structural and fabricated parts in the next two years, according to Dr. J. A. Neumann, president and director of research of American Agile Corp. That his views are shared by industry is evident from the number of new plants going into production in the near future.

Koppers Co. expects its Kobuta, Pa. plant to be in operation this fall and in full production in the spring. Also scheduled for spring operation is the South Charleston, W. Va. plant of the Bakelite Co. Fall production is expected by Du Pont, at Orange, Texas.

Applications of the older polyethylenes were limited because of the low tensile strength and lack of rigidity and inability to withstand high temperatures. The newer products, with high tensile strength and ability to withstand high temperatures, are the result of processes evolved by Phillips Petroleum Co. and Dr. Karl Ziegler of Germany's Institute for Coal Research, independently and simultaneously. Both

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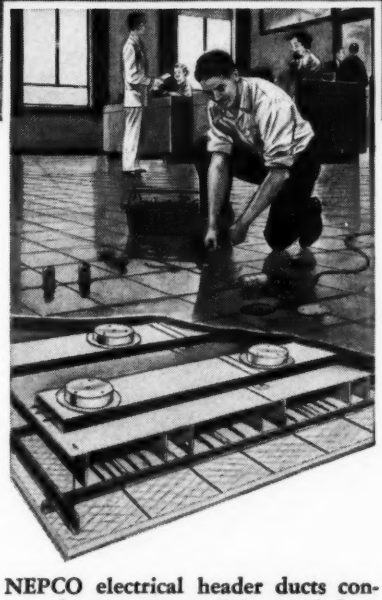

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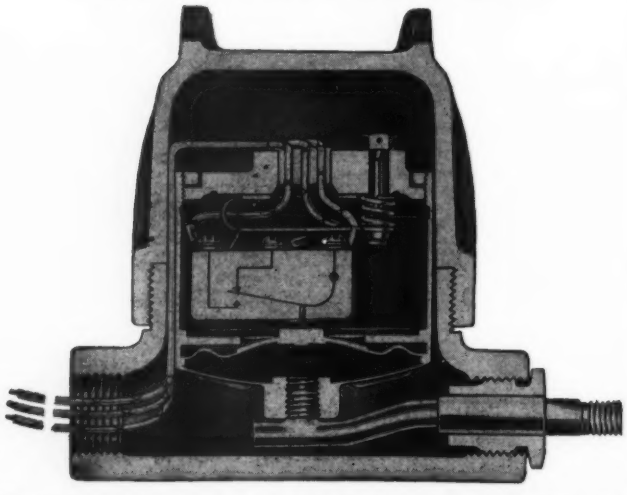

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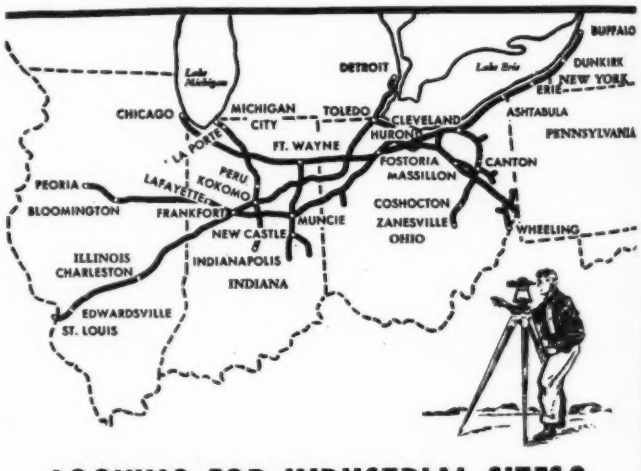
processes have the added advantage of producing the resin without use of the very high pressures and temperatures formerly required. The Phillips' product is called Marlex 50 while that being produced by the Ziegler method is marketed under the trade names selected by the licensees. American Agile differentiates between its converted resins by calling the older material Agilene LT (low temperature, low tensile) and the new product Agilene HT (high temperature and tensile).

Tensile strength of the HT is 6000 psi compared to 2000 psi for LT. And HT can withstand continuous temperatures of 250 F while LT cannot be used continuously above 170 F and will soften at 220 F. In rigidity tests HT stiffness modulus has gone to 150,000 psi and LT only to 30,000 psi.

When LT was subjected to high energy irradiation at American Agile laboratories, its melting point and tensile strength were increased appreciably. Dr. Neumann's staff, currently making similar tests with the HT, have found that its tensile strength, elongation, and temperature resistance will also be increased by irradiation.

Committee Suggests Ways to Improve Federal Engineering Corps

In an effort to make Federal Service more attractive to engineers, the U. S. Civil Service Commission is currently studying recommendations pre-



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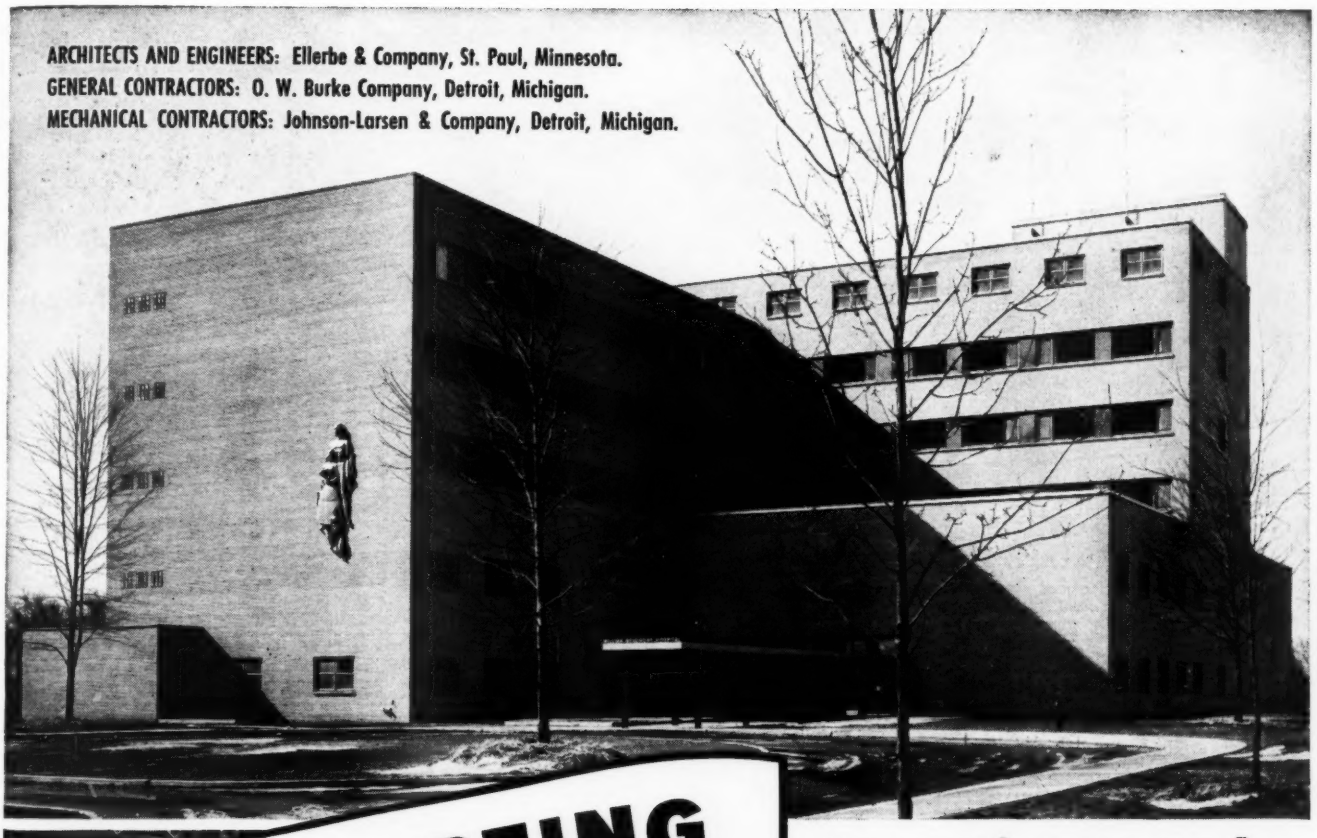

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sented by an engineering Advisory Committee made up of engineers in Government, private practice, and engineering education.

The Committee, headed by Joseph H. Ehlers, field representative of the American Society of Civil Engineers, favors clearer separation of professional from technicians positions and training outside Government for Federal workers assigned to unusually specialized and complicated Government jobs.

Stricter hiring standards are recommended, including a requirement of a bachelor's degree in engineering for entry into the two lowest grades—Engineer GS-5 and Engineer GS-7; a proficiency examination for entry into intermediate grades—Engineer GS-9 to 11; and adequate professional standing and recognition for promotion to Engineer GS-13 and higher grades.

The Committee also approved Commission action toward higher than minimum pay rates for engineers and physical scientists and to encourage programs for employment of student trainees.

Besides Chairman Ehlers, members of the Advisory Committee are Dr. James D. Forrester, dean, University of Idaho School of Mines; Ezra B. Whitman, past president of ASCE; Dr. Blake R. Van Leer, president, Georgia Institute of Technology; Leslie N. McClellan, chief engineer, Bureau of Reclamation; N. W. Dougherty, dean of engineering, University of Tennessee, and president of the American Society for Engineering Education. ▲▲

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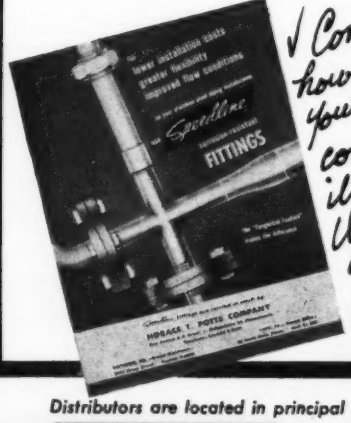

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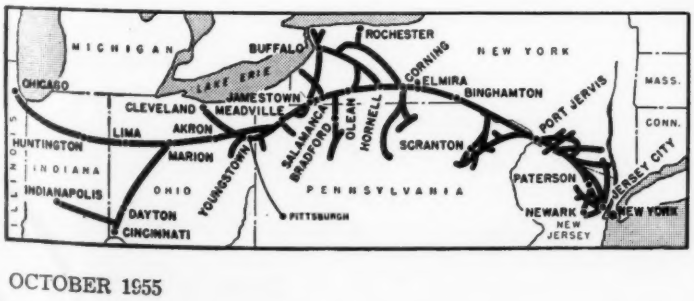

D.M. Lynn, Assistant Vice President
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Notes FROM ABROAD

Economy-Minded Scots

The city of Edinburgh in Scotland has just opened a new refuse-disposal plant that can produce 16 to 17 tons of compost (having considerable value as a fertilizer) daily from 20 tons of rubbish. The composting plan, supposedly the first of its kind to be commercially installed in the United Kingdom, is being tried initially at only one of the city's garbage depots. If it proves to be a paying proposition, some tight-fisted Scotch citizens, who so far have been highly critical of spending close to $110,000 on this new development, may feel more kindly towards composting and agree to finance similar installations to take care of Edinburgh's 400 tons of daily refuse.

First All-European Company

The ministers of Transport of Austria, Belgium, France, West Germany, Italy, Luxembourg, Holland, Spain, and Switzerland have agreed to set up the first all-European company to undertake the financing of railway rolling stock in the various countries. The principal aim of the new company, called "Eurofirma," will be to assist the railway administrations to modernize their rolling stock and at the same time to encourage the concentration of orders and reduction of prices.

The concern will be set up for a period of 50 years with an initial capitalization of approximately $12 million. Its first operation will deal with the purchase of standard freight cars for the renewal of the "Europ" pool which is jointly managed by ten European representatives. It is especially interesting to note that the founders of Eurofirma eventually expect to extend their activities into other fields—possibly highways and electrical power distribution networks in their countries.

Danube Turbines

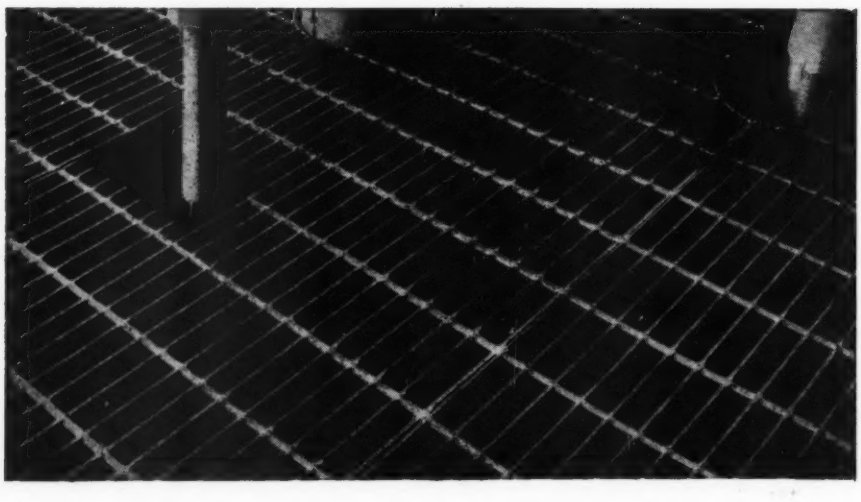
The Swiss firm of Escher-Wyss has built two Kaplan turbines of 39,400 hp for the biggest river hydraulic plant in Europe, located at Jochenstein, near Passau, on the Danube. The plant will be able to supply about 1 billion kwh of electricity per year when it is completed in the fall of 1956.

Industrial Liaison

The industrial liaison and public relations firm of Edwin Hartrich & Associates has opened an office in Dusseldorf, Germany to facilitate the exchange of economic information in the fields of aviation, automation, and the peaceful uses of atomic energy in industry and science between companies in the U.S. and West Germany.

Britain's Atomic Power Plant Program

Here's how Britain's atomic power plants for commercial operation are programmed. Aside from the Calder Hall Station now being completed, two gas-cooled, graphite-moderated stations are to be started in mid-1957, coming into operation in about 1961. Two



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WELDED GRATING

Tailor Made to Your Specs

Save installation time and money by having Gary factory-fabricate your open steel flooring needs. For complete description of Gary Gratings, write for Catalog No. CE-105.

FREE SAMPLE
We'll send this handy paper weight if you request it on your company stationery.

Standard Steel Spring Division
ROCKWELL SPRING AND AXLE CO.
4015 East Seventh Avenue • Gary, Indiana

Delivery...ON TIME...

A delay on this particular job meant valuable time lost . . . dollars wasted . . . Ric-Wil, not only prides itself in offering the finest in prefabricated insulated piping, but takes pride in ON TIME DELIVERY . . . and speaking of delivery . . . the best way to meet piping construction schedules is to contact your Ric-Wil representative early in the planning stage. He will be glad to help on scheduling delivery . . . and "lend a hand" on technical information as well.

New Ric-Wil catalog is available . . . write for your copy . . . now.

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

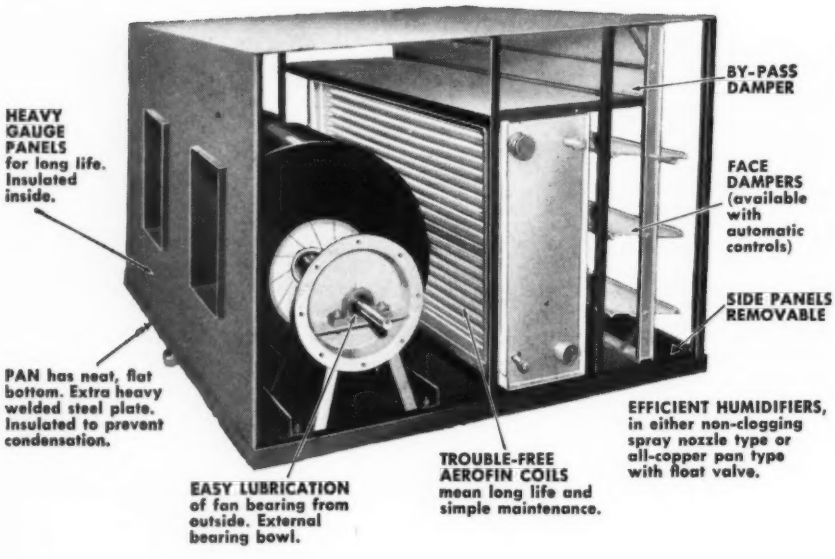
RIC-WIL INCORPORATED

PREFABRICATED INSULATED PIPING SYSTEMS

BARBERTON, OHIO

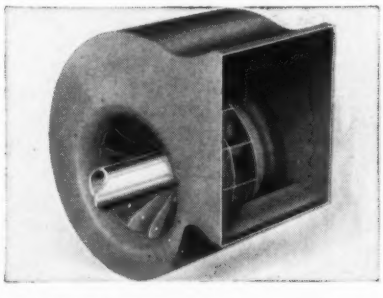
"Buffalo"

AIR CONDITIONING CABINETS
ARE BUILT TO
STAY SOLD!


HEAVY GAUGE PANELS for long life. Insulated inside.
BY-PASS DAMPER
FACE DAMPERS (available with automatic controls)
SIDE PANELS REMOVABLE
PAN has neat, flat bottom. Extra heavy welded steel plate. Insulated to prevent condensation.
EFFICIENT HUMIDIFIERS, in either non-clogging spray nozzle type or all-copper pan type with float valve.
EASY LUBRICATION of fan bearing from outside. External bearing bowl.
TROUBLE-FREE AEROFIN COILS mean long life and simple maintenance.

The above view of a "Buffalo" PC Cabinet (with side panels removed) shows why these units give *lasting satisfaction on the job.* It's part of what we call the "Buffalo" "Q" Factor*. From filter box to outlet, construction is both heavy-duty and convenient for maintenance. You'll like their ease of installation, too — this horizontal PC Cabinet can be placed directly on the floor or suspended. And where space is short, use "Buffalo" VPC Cabinets. These vertical models are in three demountable sections for moving in thru standard building openings. All models available with air washer sections, too, if desired. Capacities from 875 to 22,000 cfm. *Bulletin 3703A* gives full details. Write for your copy!

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*



STABLE, EFFICIENT, QUIET DELIVERY, with "Buffalo" mixed-flow fans — much more efficient than forward curve wheels and can be operated at higher pressures and speeds at lower noise level.

"Buffalo"

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PUBLISHERS OF "FAN ENGINEERING" HANDBOOK
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING
FORCED DRAFT COOLING HEATING PRESSURE BLOWING

further stations will be completed 18 months later. The first four of a second group of stations will be started in 1960 followed by an additional four in 1961-62. The total output from the first four stations will be between 400 and 800 megawatts and the total installed capacity of the second group of eight stations should be well over 1000 megawatts. The ten year program, therefore, should provide a capacity of about 1500 to 2000 megawatts, which will be approximately a quarter of the amount of generating capacity needed in Britain during this period. It's assumed that the remaining required capacity will be furnished by conventional power plants.

Natural Gas Pipeline

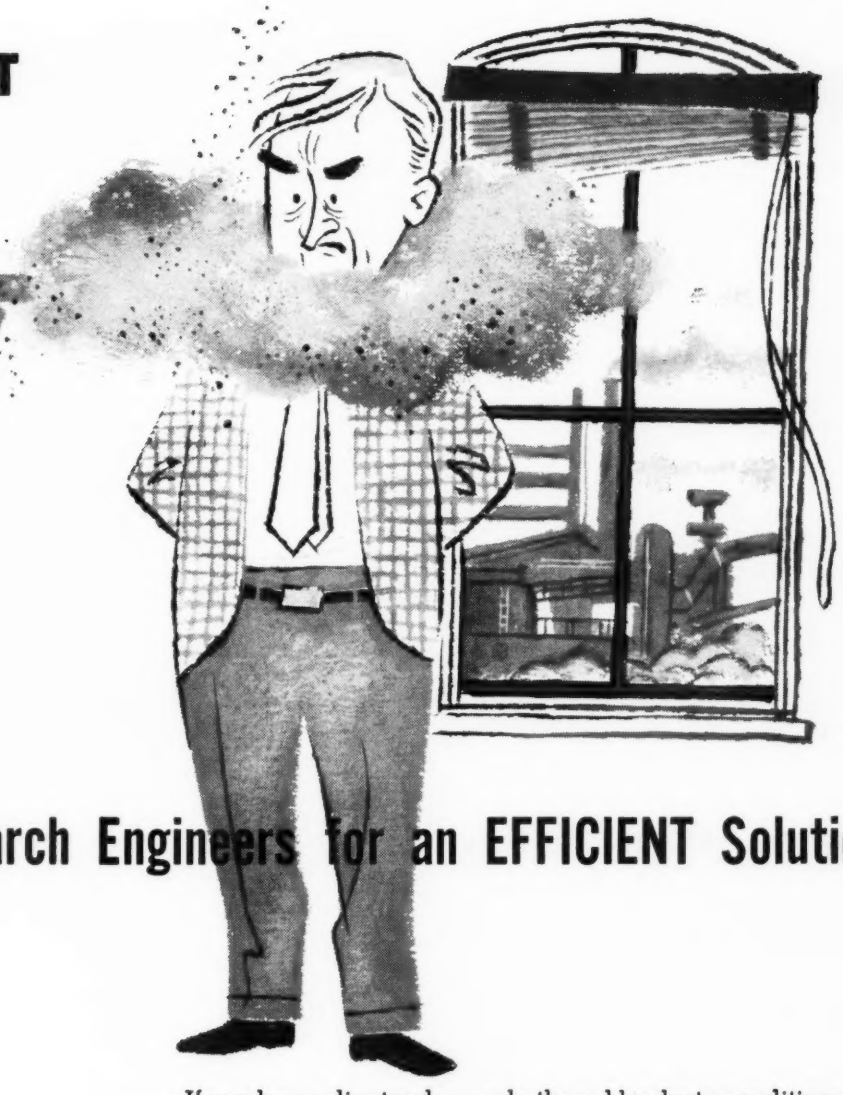
A 100-mile pipeline to bring natural gas to Genoa and to the industrial areas of the upper Po Valley has now been fully opened. The Cortemaggiore-Genoa pipeline is 16 inches in diameter and will deliver 3 million cubic meters of natural gas a day to the jute industries of Carrosio, the steel and iron works at Bolzaneto, the Delta metallurgical works, the municipal gas and water works, Ansaldo Railway Construction Co., and the country's most modern steel plant, Ansaldo S. Giorgio, which alone will consume 230,000 cubic meters per day. Many other industries in the area will undoubtedly hook into the pipeline very shortly.

Australian Steel

As part of a $160 million program of industrial expansion, Australia has officially opened two new mills — a $65 million hot strip rolling mill and a $22-½ million cold strip rolling mill — at Port Kembla, New South Wales. The former will increase output of sheet steel by one million tons a year while the latter will convert the sheet steel for use in manufacture of Australian products from refrigerators to automobiles.

The mills stand on 100 acres of

GOT A CLIENT WITH A DUST PROBLEM?



Call in Johnson-March Engineers for an EFFICIENT Solution!

If you have clients who are bothered by dusty conditions in their plant operations, the fastest and easiest way to solve your problem is to call on Johnson-March dust control engineers.

No matter what size or type of plant . . . what type of material is involved . . . or in what operation the dust occurs, Johnson-March has the experience necessary to recommend an effective liquid or dry system to stop dust at lowest possible cost.

PROVEN RESULTS IN:

Power plants • steel mills • chemical plants • foundries • asphalt plants • rock crushing plants • coal mines • metal mines • docks • conveying operations • stack dust control.

Write to us, outlining your clients' dust control needs. We will work with you in analyzing the dust conditions and make recommendations at no obligation.

Johnson March

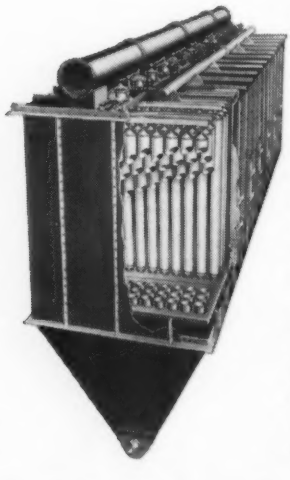
Dust Control Engineers

DEPT. CE2, 1724 CHESTNUT ST., PHILADELPHIA 3, PA.

CANADIAN REPRESENTATIVES: G. F. Sterne & Sons, Ltd., Brantford, Ontario

That's the guarantee you get with **Norblo** Automatic Bag Type Arresters

By "constant" we mean what operating men *expect* it to mean when applied to dust collection — *no* loss of suction drop, *no* down time, *no* variation in capacity.



Norblo's unit compartment system, with automatically controlled progressive and cyclic bag cleaning maintains the full capacity for which the particular installation is engineered. Bag cleaning is easily regulated if dust loading rate should change. Only one compartment is cut out at a time for cleaning (and that for only a few seconds) by means of moderate shaking which insures long bag life. A small quantity of reverse air is used to prevent unwanted dust flow during shaking operation. Excess dust is dropped without destroying the desirable basic filter cake.

Profitable, consistent performance of Norblo automatic dust and fume collection equipment is demonstrated in hundreds of important installations. If you need this facility for production, for salvage, or for good housekeeping, ask Norblo engineers what they can do for you. Write for Bulletin 164-4.

The Northern Blower Company
Engineered Dust Collection Systems for All Industries
6426 Barberton Ave. OLympic 1-1300 Cleveland 2, Ohio

land reclaimed from Tom Thumb Lagoon, to the north of the old steel works plant. Foundations for the new mills took 5500 deep driven steel piles and 3-½ million cu yd of filling.

Tower Packing

Great Britain's Atomic Energy Research Establishment, Harwell, England, has developed a new tower packing rated two and a half times more efficient than bubble cap trays and 1.4 times more effective than the recently developed slat-type tray, on the basis of capacity and equivalent heights.

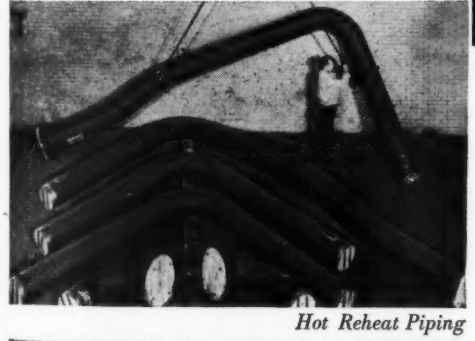
Originally developed to remove heavy water from ordinary water by distillation, the packing is now being used in a multimillion dollar plant being built in New Zealand to produce heavy water using geothermal steam as a heat source.

In the U. S., Fractionating Towers, Inc., of West New York, New Jersey, has been licensed to manufacture the material under the trade name of Spraypak. Since July of this year the packing has been under test in a major plant of one of the largest U. S. chemical firms, located in Charleston, West Virginia. In this installation, 60 ft of Raschig rings were replaced with 30 ft of Spraypak in a seven foot diameter, high pressure absorber operating at 1000 psi. With only half the height of the old packing, Spraypak almost doubled the previous capacity at the same number of theoretical trays.

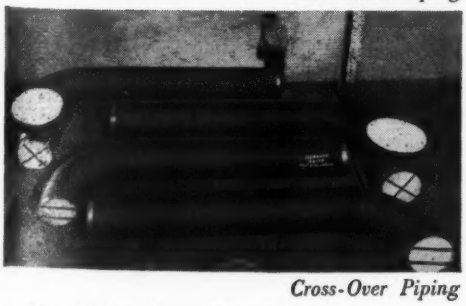
The packing is an expanded metal having openings that are louvered and pitched in the direction of liquid flow. In large towers, it is assembled in the form of interlocking horizontal diamond-shaped cells placed adjacent to and over one another. Liquid passing down the column flows as a thin film along the walls of cells into the trough between adjacent units. The small pool of accumulated liquid divides and flows down the mesh to the next lower cell. Rising gas or vapor passes through the louvered holes in the expanded

Manual metallic-arc field welding. Electric coils, wound around areas adjacent to weld, are used in preheating, and in local stress relieving after completion of weld.

Main Steam Piping



Hot Reheat Piping



Cross-Over Piping

Shop fabricated assemblies above are produced to sizes which installation and shipping facilities permit.

FIELD ERECTION by P.P.&E.

Assures Safe, Efficient Operation of HIGH TEMPERATURE, HIGH PRESSURE PIPING

Pittsburgh Piping and Equipment Company was among the first to recognize the importance of complete piping fabricating service, including the responsibility for erection of the piping system.

At P.P.&E. sub-assembles are shop fabricated in sections as large as shipping facilities and installation area permits, are checked for dimensional alignment, and delivered ready for accurate erection. Field welds are planned for maximum accessibility. Consequently, erection by skilled, specially trained craftsmen is facilitated.

An experienced P.P.&E. field organization handles all erection problems, and coordinates field work with shop fabrication so that materials arrive on schedule, and in the sequence which permits erection to proceed rapidly and efficiently.

PRODUCTS AND SERVICES

Carbon Steel Piping	Forged Piping Materials
Cast Iron Fittings	Headers
Cast Steel Fittings	Manifolds
Chrome-Moly Piping	Pipe Bends
Copper Piping	Stainless Steel Piping
Corrugated Piping	Van Stoning
Creased Bends	Welded Assemblies
Expansion Bends	Welded Stainless Steel Tubing
Flanges	Welding Fittings

PP-15

Pittsburgh Piping AND EQUIPMENT COMPANY
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835 BEACH ROAD—HAMILTON, ONTARIO

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Los Angeles	1830 North Alexandria Ave.
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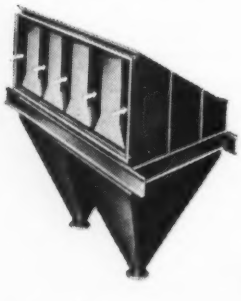
Your plant and equipment suffers . . . your community goodwill fades away. These problems can be solved. Prat-Daniel Collectors are designed for the control of industrial dusts and flyash. Multiple small diameter tubes provide powerful centrifugal forces, resulting in sustained high collection efficiency . . . even with ultra-fine dusts.

Whether the problem is industrial dust or flyash, you are assured of satisfaction with P-D Collector Systems, engineered to meet your specific needs.

Write for Reprint No. 102 titled, "What Type Collector?"



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Project Engineers
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GREENWICH, CONN.
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Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.; Toronto 5, Ont.

Designers and Manufacturers
PRAT-DANIEL CORPORATION
SOUTH NORWALK, CONN.
POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

metal so that intimate spraying action occurs between descending liquid film and rising gas.

Under the licensing arrangement with the Ministry of Supply of Great Britain, Fractionating Towers will exchange developmental information with Britain's Atomic Energy Research Establishment, and S. Schwartz & Associates will provide engineering and technical services in the U. S. and Canada.

Construction Abroad

A one year contract to assist the Air Force in supervision and inspection of construction on Third Air Force installations in England has been awarded by USAFE to the architectural-engineering joint venture of Frank Grad & Sons, of Newark, New Jersey, and Seelye, Stevenson, Value & Knecht, of New York. The same joint venture has been engaged for the past four years in similar work on USAFE jet air bases in France.

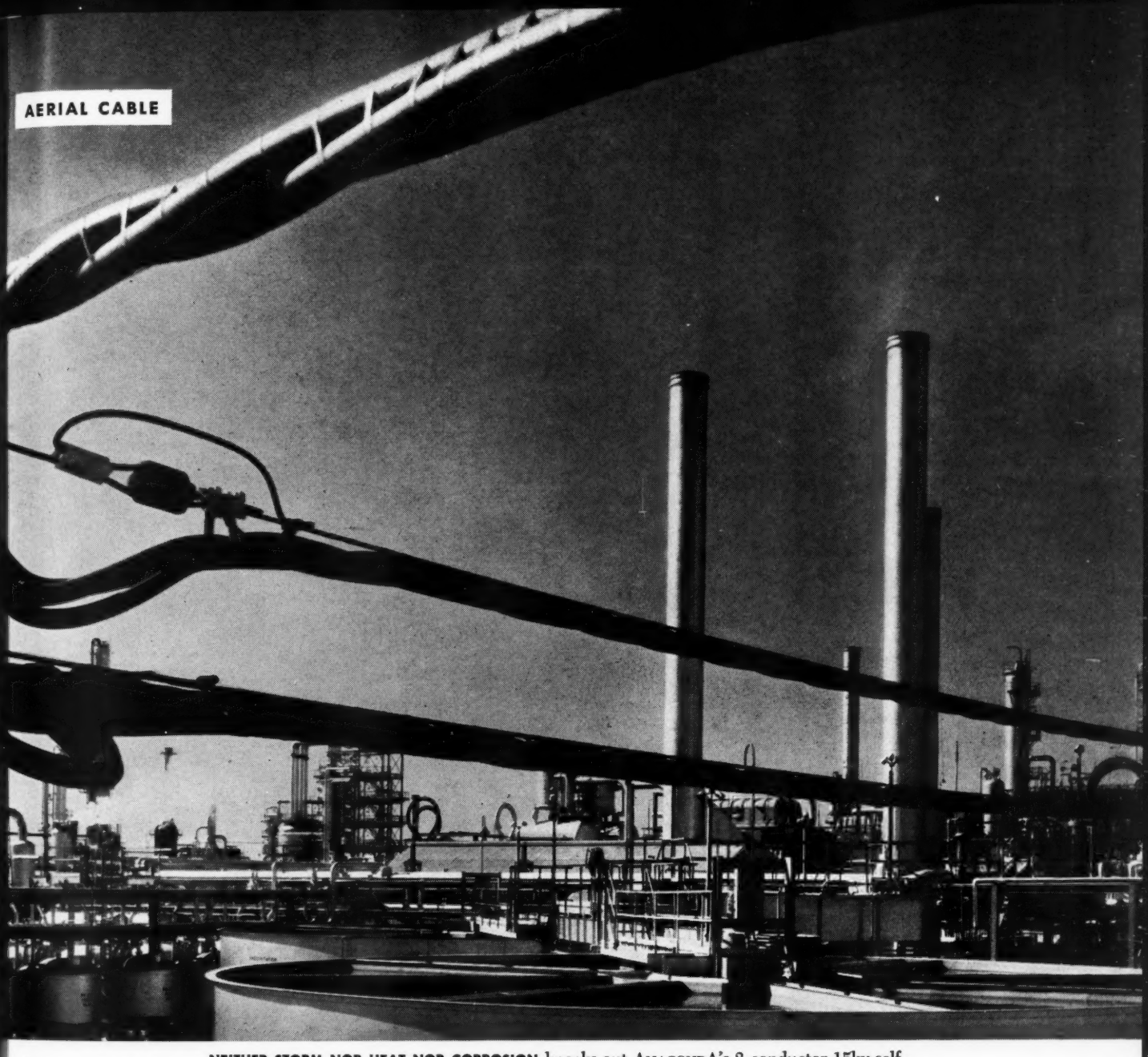
Foreign Projects

The Lummus Company has started construction on Puerto Rico's first complete ammonia products plant. The anhydrous ammonia, sulfuric acid, and ammonium plant is being built at Guanica, Puerto Rico for Gonzales Chemical Industries, Inc.

The Empresa Nacional de Luz y Fuerza of Managua, Nicaragua, has chosen The Kuljian Corporation for design, engineering, procurement of materials and equipment, inspection of construction and initial operation of a 30,000 kw power plant at Managua.

Atoms for Norway

Gunnar Randers, Director of the Norwegian Atomic Institute, announced that a five-year research program, to be presented to the Norwegian Parliament, aims at construction of a prototype atomic reactor for marine propulsion. If funds are made available, such a reactor, it is stated, could be ready within 2½ years. ▲▲



NEITHER STORM NOR HEAT NOR CORROSION knocks out ANACONDA's 3-conductor 15kv self-supporting Aerial Cable—shown here at Shell Oil's modern new refinery at Norco, La.

GO UP TO BRING COSTS DOWN

—with AnacondA Aerial Cable

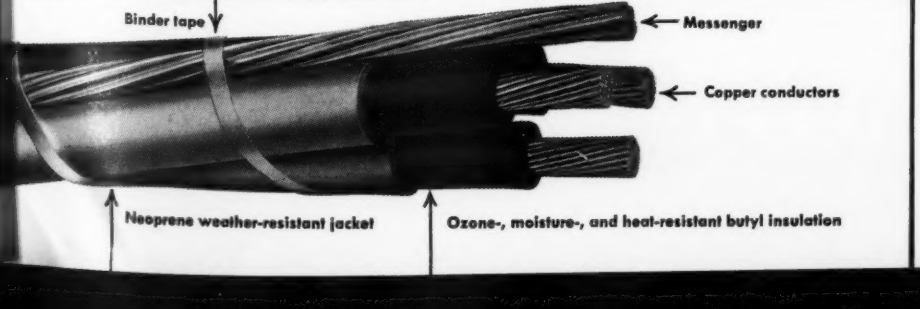
When new power is needed or when old circuits must be replaced quickly and at low cost—more and more plants are turning to ANACONDA Aerial Cable.

In plants where the maze of pipes and other underground structures often make installation of ducts or buried cable costly or difficult. This cable solves the problem.

It's fast, easy to install—particularly in crowded areas. No special ducts or crossarms or insulators are needed. Even in open areas, this rugged, neoprene-jacketed cable costs much less than buried systems.

You can see that it is neat. It is equally safe . . . and reliable!

Today's finest aerial cable! Type AB butyl insulation gives ANACONDA Aerial Cable the finest performance record. For the full story, call the Man from Anaconda today. Or write: Anaconda Wire & Cable Company, 25 Broadway, New York 4, New York. 55279



Ask the Man from

ANACONDA®

about your

High-voltage Aerial Cable

MEN IN ENGINEERING

Potomac Electric Power Co. has retained Stone & Webster to design and construct a 100,000 kw extension to the Potomac River Generating Station, in Alexandria, Va., to augment existing supply to the District of Columbia.

Harza Engineering Co., Chicago, announces appointment of Arthur P. Geuss as vice president and chief engineer and C. Keith Willey as vice president and western manager.

Rowland M. Garratt has joined the laboratory staff of Timber Engineering Company, research affiliate of the National Lumber Manufacturers Association.

Charles R. Waters, formerly district engineer, District 5 New York State Department of Public Works, has joined De Leuw, Cather & Brill as an associate and will serve as a special consultant to DeLeuw, Cather & Co., Chicago.

The American Society of Civil Engineers has awarded honorary membership to the following engineers: John I. Parcel, vice president of Sverdrup & Parcel, consulting engineers; Frank A. Banks, of Grand Coulee, Wash.; Rear Admiral Leo O. Colbert (Ret.), U. S. Coast and Geodetic Survey; Park H. Martin, Allegheny Conference on Community Development.

John D. Constance, consulting engineer, announces establishment of a Guidance Consulting Service to assist engineers in preparing for their professional engineer's license. For more information contact Mr. Constance at 625 Hudson Terrace, Cliffside Park, N. J.

Engineering and construction operations of The Fluor Corp., Ltd., Los Angeles have been combined into one division with M. A. Ellsworth as vice president and general manager of the division.

The firm of Seelye, Stevenson, Value & Knecht announces that Jack L. Staunton, Chief Sanitary, Hydraulic, and Petroleum Engineer, is now an Associate of the firm.

The David B. Steinman Foundation has presented the University of Michigan with a $10,000 scholarship fund for the School of Engineering. During the past six months the Foundation has given a total of $60,000 in grants to six educational institutions.

At Parsons, Brinckerhoff, Hall & Macdonald, Maurice N. Quade, Partner, has been awarded the Thomas Fitch Rowland Prize for his paper "Special Design Features of the Yorktown Bridge," by the American Society of Civil Engineers. Joseph Schachtman, Controller at PBH&M has been elected to membership in the New York City chapter of the Controllers Institute of America making his firm the only consulting engineering organization affiliated with that Institute.

William E. Short, electrical engineer, announces opening of an office for the practice of consulting engineering in room 212, Randolph Bldg., 1307 E. 38th St., Tulsa, Okla.

In Kaiser Engineers Division of Henry J. Kaiser Co., C. H. Case is appointed a division manager and Paul C. Meyer is appointed assistant to the v-p and general manager.

Albert Kahn Associated Architects and Engineers, Inc. announces appointment of P. B. Kirby as chief engineer of the firm's Structural and Civil Engineering Division.

F. H. McGraw & Co. has been engaged by the U. S. Rubber Company to rehabilitate the Naugatuck, Conn. plant, which was severely damaged during the August flood.

Dr. Waldo Shumway, dean of Stevens Institute of Technology, has been elevated to the position of Provost. Dr. Lynn L. Merrill, currently head of the Department of Mathematics, has been appointed Dean of Faculty. ▲▲

EXTRA YEARS

OF MORE DEPENDABLE POWER
and at less cost per pound of steam

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GAS OR OIL

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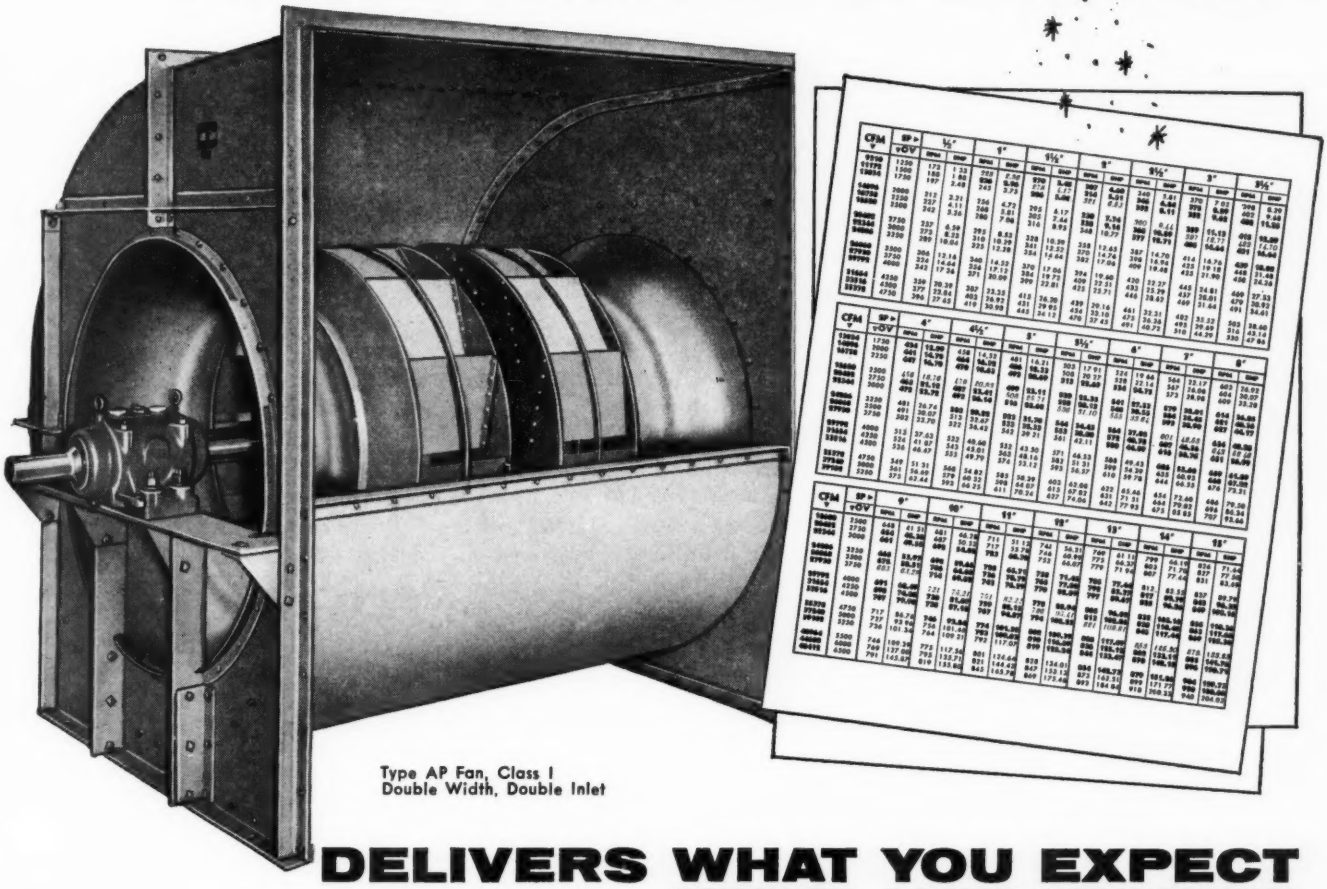
TODD NEW YORK, U.S.A.

The Product BEHIND the PERFORMANCE TABLES



Type AP Fan, Class I
Double Width, Double Inlet

DELIVERS WHAT YOU EXPECT WHEN YOU SPECIFY AND USE Bayley FANS

AND HERE'S WHY:

1. **WIDE EXPERIENCE** supplies a *sound basis* for both standard and custom designed Fan applications.
2. **AIR ENGINEERING** — creates *correct design* for smoothest performance.
3. **PRECISION COMPONENTS** — insure maximum realized efficiency.
4. **PRODUCTION SKILL** — achieves the end result you seek . . . *PEAK PERFORMANCE!*

WRITE for your copy of Bayley Bulletin 42-AP

Bayley BLOWER COMPANY

6610 W. Burnham Street • Milwaukee 14, Wisconsin

. . . To Elaborate a Little

"Reports Your Clients Want to Read," by Morris Sandel, Jr., in your August issue is interesting and thought-provoking. However, I disagree with some details.

In his opening paragraph, Mr. Sandel states his dislike of a report organized formally into sections labelled "Letter of Transmittal, Summary, Introduction, Method, Result, Discussion, Conclusion, Recommendations and Appendixes." I don't like this organization either, but for a different reason: the sequence is poor.

Our usual method is to develop the report in the following typical sequence of sections:

Letter of transmittal is bound in as the first page of the report.

It states that we are submitting the report as requested, that it covers certain ground, and that it gives conclusions and recommendations in certain fields.

We hope that the president will read this letter, and intend that it will either meet his full need for information or will interest him in reading further.

Table of Contents is a very important item. If it is omitted or if the report is not sectionalized to allow preparation of a table of contents, future reference to the report is made difficult. We break a report down into many sections and sub-sections of a few pages each, and the resulting table of contents is an excellent introduction to what the report covers and a valuable aid to reference.

Introduction is a page or two stating what we are attempting.

Scope is a page or two which defines the ground we are covering and not covering.

Next may come a section, with appropriate title, that defines the problem in some detail.

Conclusions and Recommendations are written with great care.

The danger here is that the section will be too lengthy. There is a tendency toward too much discussion of reasons for the conclusions and recommendations; this belongs farther back in the report.

At this point, we have covered the needs of the client's second echelon. They have been told what the problem is, the scope of our attack on it, and our answers. Sometimes we take this part of the main report and bind it separately as a summary report for management. In that case we also include these sections as the first part of the longer main report. It is important that tables and charts in this part of the report be presented where reference is made to them, even if it is not planned to bind these sections separately.

From here on the organization and titles of sections vary among reports. Typically there will be at least the following:

Basic lists of sources of information and assumptions that we

HERE'S THE REASON WHY

MERCOID® PRESSURE AND TEMPERATURE CONTROLS

OUTPERFORM AND OUTLAST ORDINARY TYPES

Series "D"

Available for general use, outdoor use or hazardous locations.

● HERMETICALLY SEALED CONTACT

Always dependable—whether it operates once per year or several times per minute. It remains operative at all times because dust, dirt, grease or moisture cannot contaminate the contacting elements.

● OUTSIDE ADJUSTMENTS

Independent outside adjustments are provided for setting both the cut-in and cut-out points.

● VISIBLE CALIBRATED DIAL

No guesswork or calculations are required—the pointers indicate on an accurately calibrated dial, the exact operating pressures or temperature.

● UNDERWRITERS' APPROVED

All operating ranges for Series DA-21, DA-35 and DA-55.

WRITE FOR BULLETIN 4B

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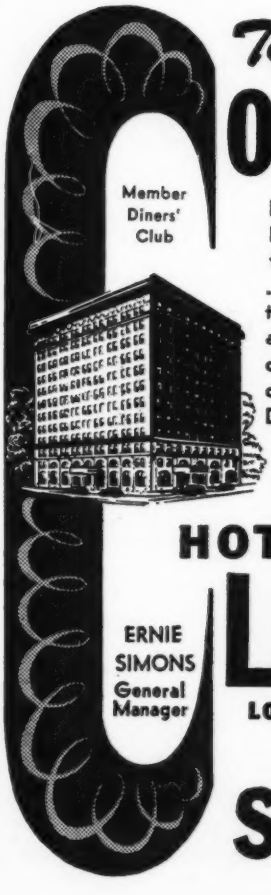


Tops in Everything

ONVENIENT

Ideally located in St. Louis, two short blocks from the Union Station and in the center of the Wholesale District . . . Preferred, always by experienced travelers because of its outstanding advantages— Every room with combination tub and shower . . . and circulating ice water.

Delicious food . . . cheerful service.

AIR-CONDITIONED ROOMS

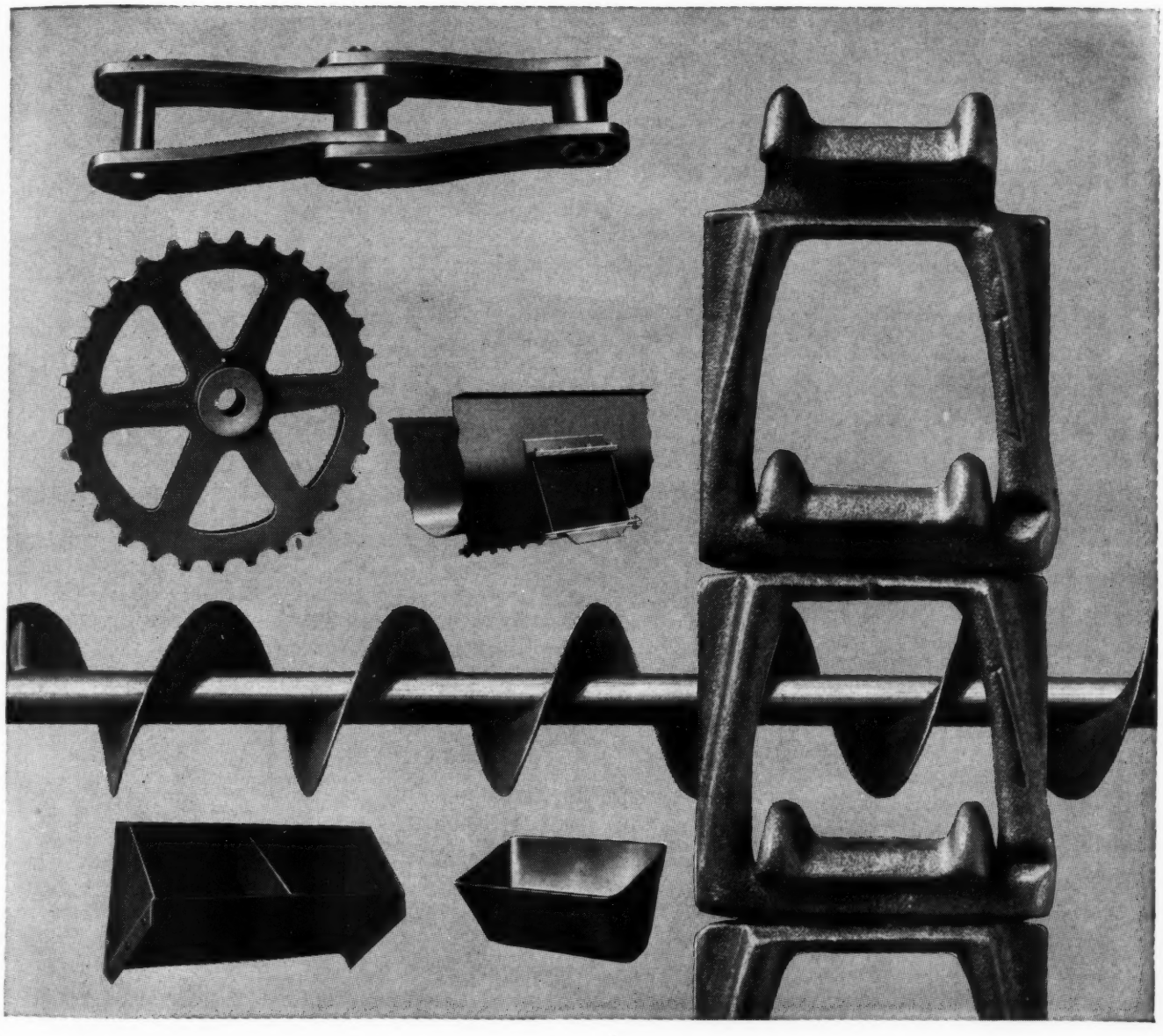
350 rooms from $3.50

HOTEL LARIDGE

LOCUST ST. AT EIGHTEENTH

Free Parking

ST. LOUIS



when your conveying job calls for

Stainless Steel . . . call for JEFFREY

Many companies make fine stainless steel. Jeffrey can fabricate this metal with a high degree of skill. Your materials handling problems calling for stainless steel are our specialty.

Experienced engineering and production personnel, plus special manufacturing equipment, enables Jeffrey to build entire handling systems, furnish standard conveyor units, or supply replacement parts in stainless steel.

Jeffrey's experience with stainless steel fabrication includes work with every grade metal from the costly to the relatively inexpensive types. Craftsmanship remains high regardless of the grade metal specified. We can cast, weld, roll or bolt stainless steel without altering the quality of the raw material.

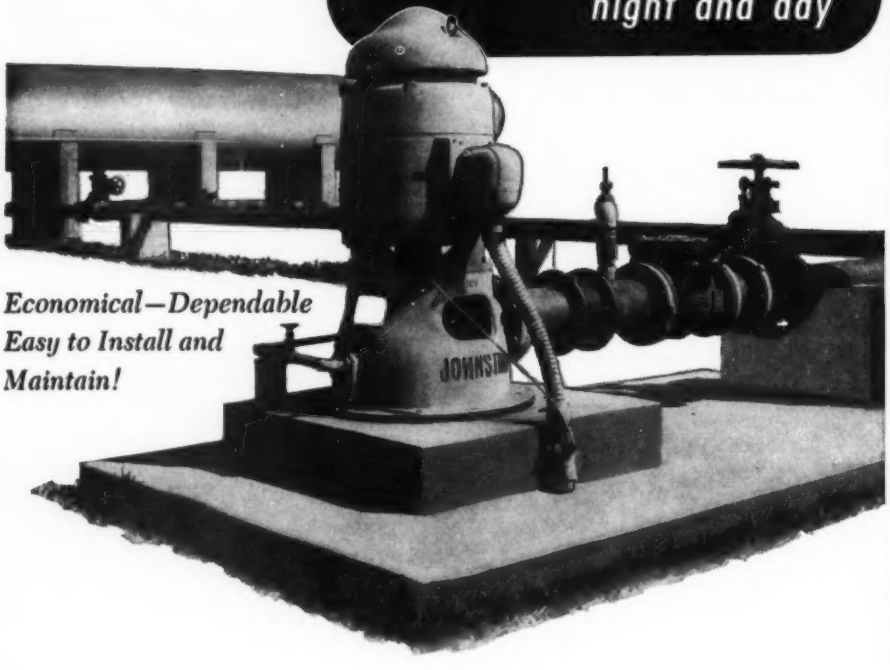
Next time you have a handling operation involving corrosive materials, write to Merchandise Sales Division, The Jeffrey Manufacturing Co., Columbus 16, Ohio. We'll be glad to solve your problem with high-quality stainless steel products.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT
TRANSMISSION MACHINERY • CONTRACT MANUFACTURING

Wherever water is needed —you'll find

JOHNSTON
VERTICAL PUMPS
are on the job night and day



Economical—Dependable Easy to Install and Maintain!

Industrial and municipal engineers are among the shrewdest judges of pumps. They know from experience that water supply pumps must be designed to stand up under hard usage day and night, year after year, with minimum down time for repairs. Backed by nearly a half century of know-how, Johnston Pumps are easy to install and maintain, economical to operate, and offer superior performance. Write for details.

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JOHNSTON PUMP COMPANY

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have made regarding present or future conditions. Sometimes this belongs in the summary group.

Discussion of conclusions and recommendations, often with development of alternative plans of action, their costs and their relative operating advantages.

Appendixes tend to be varied. Typical material is detailed data on present conditions, and discussions that are too long or insufficiently pertinent to the main theme for inclusion in the main body of the report.

This type of report seems to me to fill both of the conflicting desires that Mr. Sandel mentions. It is complete, and doesn't leave the client feeling that he received a report that orders him around without explaining and proving why. Yet it is organized like a good newspaper story, so the reader can go as far as he likes and always stop with a coherent picture.

Most of Mr. Sandel's other theses I quite agree with, but I have comments on a few.

Mr. Sandel's point about avoiding long sentences is well made. However, I wouldn't join him in worrying about making sentences too short and simple. Very little writing by engineers in my experience errs in that direction.

Finally, I think there is a point to be made about dressing up a report, *a la* Madison Avenue. The writer of a sales brochure can't be sure that anyone will read his product. He must catch the reader's attention and keep it. A report has cost a client a lot of money, and I feel that we can be sure that some of his people, at least, will read it carefully. Certainly it should be made interesting and convenient for him, and our reputation will benefit thereby. However, it does not need to be flashy, in ways that are obviously for effect. Indeed many conservative clients would react unfavorably to such an approach. Remember that top executives are accustomed to being propagandized by experts, and they probably welcome a factual and unemotional document occasionally.

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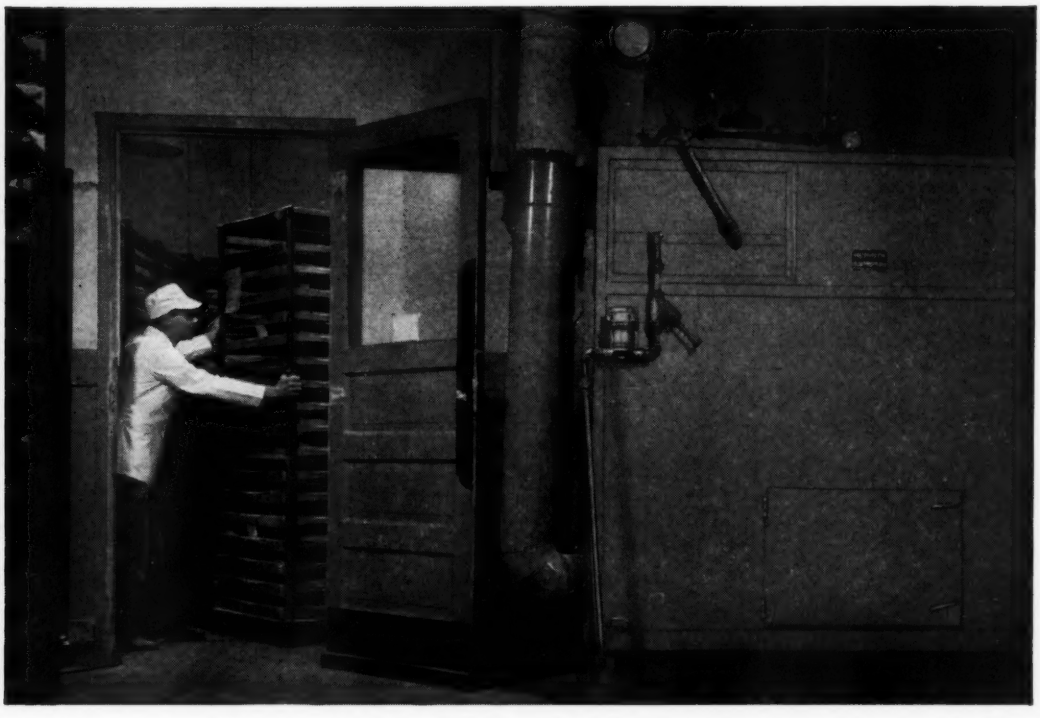

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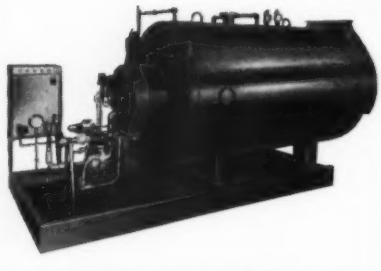

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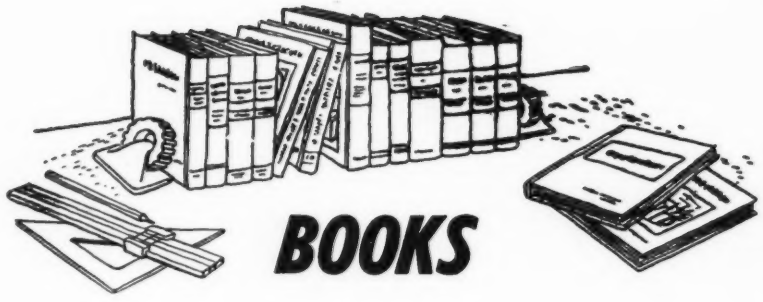

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QUALITY CONTROL, Second Edition, by Norbert L. Enrick; The Industrial Press; 181 pp; $4.00.

Reviewed by Victor A. Lennon, Associated Business Consultants

Statistical Quality Control generally is looked upon as a highly complex subject which is beyond the comprehension of those not trained in higher mathematics and statistical methods.

The author has taken this subject, stripped it of its mathematical intricacies and presented it in a practical, boiled-down manner which can be readily applied by anyone familiar with simple mathematics.

While he religiously adheres to his dedication to "directness, simplicity, and avoidance of complicated formulas," as stated in the foreword, the author does present, in abbreviated form, the mathematical bases upon which the procedures are founded. However, this phase is segregated from the application phase and is covered in separate chapters.

At the outset, the author discusses the two basic types of inspection — 100 percent or screening, as against "scientific sampling" and the advantages and disadvantages inherent in each. In presenting his case for Statistical Quality Control, he very early exposes the fallacious belief that screening (or 100 percent inspection) will assure a perfect product. However, he also sagely indicates that Statistical Quality Control is not a panacea for all inspection problems and discusses situations where it should not be used. Succeeding chapters present step by step procedures for installing Lot-by-Lot Inspection and also Process Inspection. These steps are stated very simply and concisely. Master tables for both single and sequential sampling plans are provided and their application explained. The method of establishing tolerance and control limits for the control charts used in Process Inspection are clearly presented, as well as the method of establishing range charts.

In addition, several chapters in Part I deal with subjects such as tolerances and allowances and gauging, which although not integral parts of Statistical Quality Control are closely related.

Summarily, all of the mechanics involved in establishing and operating a typical Statistical Quality Control Program are presented in an easily comprehensible manner in Part I. Guidance in the selection of the type of program to use is also provided.

Part II endeavors to discuss variations and specialized techniques which may be required in unusual situations. However, here again, the neophyte need not absorb this section in order to embark on the usual type of Statistical Quality Control Program.

In addition, the author devotes several chapters to the organizational and human relations problems involved in installing a Quality Control Program. Chapter XI, "A Typical Case History," in effect, tells how to sell such a program to Top Management, while Chapter X indicates several alternate positions and relationships of the quality control man in the organizational structure of his company.

This book definitely is recommended for anyone interested in obtaining a practical knowledge of Statistical Quality Control without becoming encumbered with the theoretical aspects of statistical probabilities and formula derivations.